MACHINERY.

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NOTES FROM A CLEVELAND SHOP.

C. H. BENJAMIN.

I visited the shops of the Cleveland Machine Screw Company lately, and was shown the various processes of manufacture by Mr. J. B. Clyne, the superintendent, who very kindly answered my numerous questions. Some of the things which I shall try to describe may not be new to all your readers, but they were new to me.

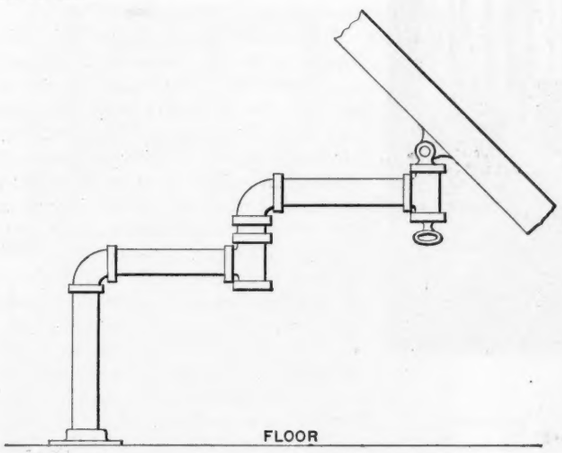


FIG. 1. SUPPORT FOR BLUE-PRINTING FRAME.

A more appropriate name would seem to be the Cleveland Screw Machine Company, as screw machines are the principal output of one department of the works, while the manufacture of machine screws was only conspicuous by its absence.

In the drawing room I noticed that all the tracings are made on bond paper instead of cloth, in two principal sizes, and are kept in

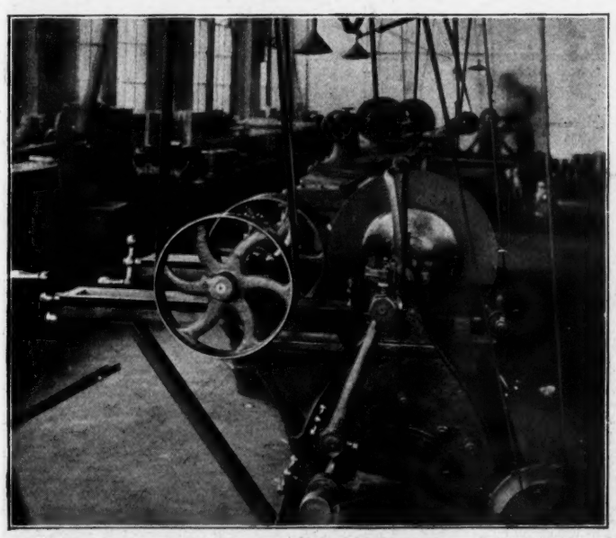


FIG. 2. GRINDING PULLEY FACES.

a vault flat, not rolled. The drawers in the vault are made very shallow and slide on feathers at the sides, so that no space is lost in horizontal partitions. I saw at one of the windows in the drawing room a simple but ingenious hanger for a blueprinting frame, made entirely of pipe and fittings, as shown in the sketch Fig. 1, and having all the necessary adjustments.

The shops proper are in two parallel three-story buildings, some 30 feet apart. In a wing which connects the two are located all the elevators, stairways, wash-rooms, etc., and this wing is separated from the main buildings by fireproof doors. This leaves the shops free from openings in the floors, and as the construction throughout is of the so-called slow-burning type, the risk from fire seems to be slight.

I was favorably impressed with the arrangement of the machine shops on two of the floors. A long room, 40 x 200 feet, is lighted from the two sides, while down the center is a row of stout oak columns dividing the room into two aisles. There is but one line shaft running the whole length, supported by post hangers on one side of the columns. On this side of the shop are located the lighter machine tools, mostly lathes, in two long rows back to back (Fig. 4). The upright drills are mostly be-

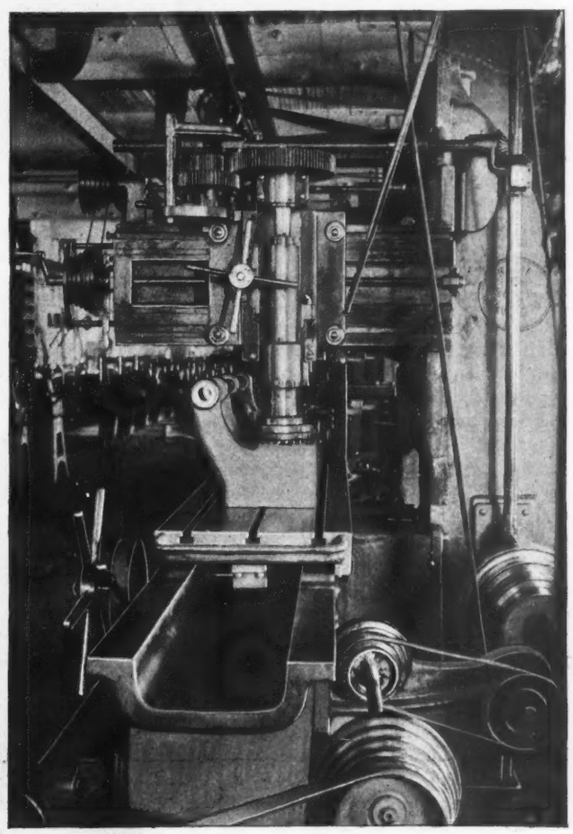


FIG. 3. A HEAVY MILLING MACHINE.

tween the columns and driven directly from above, and all the heavier machine tools are near the columns or, in the case of the planers, bunched at one end. This leaves one side of the shop practically free from counter-shafts and belts to be used for setting up machines.

A light traveling crane, consisting of a single I-beam mounted on trucks, runs on two parallel tracks the whole length of the shop and gives command of the entire floor on this side, including all the larger machine tools. The crane carries two trolleys, as shown in the cut, one light and quick for ordinary work, and a more powerful one for emergencies.

In this same room I noticed a large open side machine, resembling a planer at first sight, which proved to be a milling machine made by Beaman & Smith, of Providence, R. I., and

used principally for finishing large flat surfaces with an end mill. This machine is shown in Fig. 3, with the bed of a screw machine in position for milling. All work of this character is done on a milling machine with greater uniformity than would be possible on a planer, and at about one-fourth the expense. In fact, the milling machine is used here almost to the exclusion of the planer and the shaper.

FIG. 4. SHOWING ARRANGEMENT OF SMALL TOOLS.

Besides being used for curved and irregular forms where it is generally acknowledged to be superior, it is here beating the planer in the latter's own territory—i. e., finishing flat and rectangular parts.

I noticed particularly the finishing of the top of a screw-machine leg in an ordinary plain milling machine, using a cutter with inserted teeth. The feet are held in a jig so as to bring them parallel to the plane of the cut and insure the top being finished true with the bottom. The finish left by an end mill is not so pleasing to the eye as the broad stripes left by a planer, but I am inclined to think it is just as accurate.

As the milling machine is displacing the planers, so in this establishment is the grinding machine crowding hard on the lathe. Fig. 2 shows a dry grinding machine for finishing the rims of cast-iron pulleys. The mandrel which holds the pulley is so mounted that by turning the cross-feed cranks shown in the cut the rim may be ground straight or crowning. The pulleys are finished more accurately than by the old process, and at about one-half the expense.

In this same room is done all polishing, and all operations involving the use of emery are kept away from the machine tools. Just beyond the pulley grinding machine in the cut may be seen a wet grinding machine for doing all work which requires special accuracy, such as finishing the turrets of the screw machines.

Cone pulleys are at present turned in a lathe, but a special tool holder is used carrying as many tools as there are steps on the cone and turning them all at once. The tools are adjusted to the right relative position by means of a hardened template corresponding to the face of cone. I have seen this fixture described before, but it may be new to some of your readers.

The arrangement of the second floor of the machine shop is similar to that of the first—machines on one side, setting-up room on the other. There is no traveling crane here, but a peculiar combination of truck and crane is used, which I have seen described before in your columns, I think. It is made of structural steel, the base in the form of a horse-shoe, on trucks, with an overhanging pillar crane standing on the bend of the horse-shoe. This "pterodactyl" is capable of embracing any small machine or casting, picking it up and walking off with it, while for use about planers and lathes it must be very handy.

THE BALL DEPARTMENT.

To the ordinary observer there is more that is new and strange in this department than in the machine shops.

Hardened steel balls are here made in sizes varying from 1-16 to 4 inches. The smaller sizes are roughed out by a process which I witnessed, but am not at liberty to describe. The larger sizes are first forged from the bar under a trip hammer and then cut off.

The rough grinding of the balls before hardening is done between one dry stone and a stud ring. The balls resting in a circular slot in a thin horizontal plate, and projecting slightly above and below are held between the ring and above the stone below. The stone and the ring revolve, in horizontal planes, in opposite directions and about axes slightly eccentric to each other. The ball thus gets a peculiar aggregate motion which insures every side being exposed to the grinding (Fig. 6). From here the balls go to the hardening furnaces heated by fuel oil and are raised to a definite temperature determined by a thermo-pile and galvanometer. They are next dropped into a well of oil some 12 feet deep, striking on baffle plates, as they fall, to retard their descent, and when they reach the bottom they are cool.

A constant circulation of oil is maintained, so that the amount of oil in the well is changed and cooled every four minutes. A circulating pump forces the oil from the well through a tubular feed water heater, where the heat is given up to feed water which is on its way to the boilers.

FIG. 5. INSPECTION ROOM, BALL DEPARTMENT.

Brine is used for cooling some of the larger sizes. The tempering is done by an oil bath raised to a certain definite temperature determined by a thermometer, and the balls are now ready for the final grinding.

This last is really a lapping process, the balls being rolled around in a circular groove by a rotating plate coated with emery and oil (see Fig. 7). If the balls rolled in a straight groove they would become more or less elliptical; but the fact that they are

traveling around in a circular groove, where the outer circumference is greater than the inner, induces just enough side turning to insure uniform grinding.

That we may not accept this last statement without proof, let us climb another flight of stairs to the gauging room on the upper floor (Fig. 5). To me this was the most interesting room of all, as proving the success of the ingenious methods already described.

In the middle ground of the picture may be seen a row of gauging machines with their hoppers and inclined planes. Those machines are automatic in their action, the balls being delivered from each hopper one at a time to an inclined slot, down which they roll between two hardened and polished straight-edges. The straight-edges are set one and one-half thousandths (.0015) of an inch nearer together at the top than at the bottom, and are ruled transversely into sections. When the ball on its way

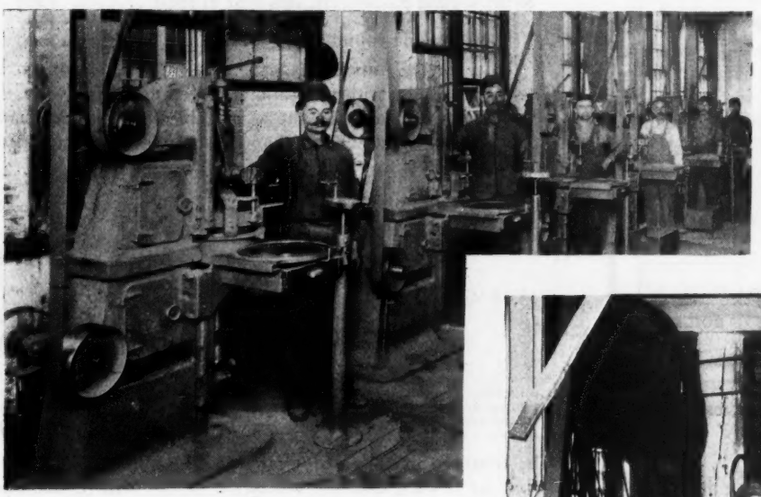


FIG. 6. ROUGH GRINDING.

down the incline reaches the width between the straight-edges corresponding to its own diameter, it drops through, and is led by a chute underneath to its own appropriate drawer. The difference between the two adjacent compartments is only one thousandth of an inch.

Even this process does not prove that the balls are round. A ball which is not round, however, will not roll in a straight line on a plane surface. Around the room shown in Fig. 5 are seated sharp-eyed girls, each one holding in her hands a shallow tray with a plate-glass bottom, which she continually tips this way and that, watching all the while the wanderings of the hundred or more balls which roll back and forth slowly on the polished surface.

If one of the little fellows has any eccentricity, he shows it as plain as a man with one leg shorter than the other. Flat spots are detected by the keen eyes of the operator, and all the sinners are summarily removed by means of a slender steel magnet. The superintendent informed me that the girls could also detect a soft ball by the peculiar appearance of its surface. One of these was handed to me, but my untrained eyes could not distinguish it from its neighbors. I could not help thinking that if at the last judgment the failures are as easily detected and the proceedings as summary as in this instance, our chances are exceedingly poor.

The balls are now counted and packed in boxes for shipment. The counting is done by means of boards having in them from 100 to 500 hemispherical depressions of the right size for the particular balls to be counted. The balls in large numbers are rolled across the board, and of course just a certain number stay while the others roll off. One girl has a record of counting one million balls in a working day—or, what is more impressive, more than 1,600 a minute.

The demand for steel balls is steadily increasing, and new adaptations are every day made of them. One of the last places where one would look for ball bearings is in agricultural machinery; but Mr. Clyne informed me that there is at present quite a demand from that quarter.

Their use in most machines is confined to end bearing journals or collars where they have a field peculiarly their own.

* * *

MECHANICAL DRAFT.—7.

THE ADVANTAGES CLAIMED FOR THIS SYSTEM.

WALTER B. SNOW.

The advantages possessed by, or claimed for, mechanical draft as compared with those which pertain to a chimney, vary in their importance according to the circumstances of installation. Undoubtedly one of the first questions to be asked relates to the relative first cost of the two methods of draft production. A comparison of costs in a typical steam plant arranged first with a chimney and next with fans, will seem to make clear advantages possessed by the latter.

In Fig. 7, page 204, is shown the plan of a plant consisting of 16 water-tube boilers of approved design, each of 200 horse-power. The chimney required to produce the requisite draft when the nominal rating is somewhat exceeded is 10 feet in diameter and 200 feet high. Four feed-water economizers are provided,

VIEWS IN BALL-GRINDING DEPARTMENT. FIG. 7.—FINISHING.

and by an arrangement of dampers it is possible to pass the gases through them or directly to the chimney.

In round numbers, the cost of this plant in detail is about as follows:

16 water-tube boilers of 200 H. P. each	$50,000
4 feed-water economizers	14,000
Settings for boilers and economizers and by-pass dampers	12,000
Flue dampers and regulators	500
Chimney	16,000
Building	15,000
	$107,500

In Fig. 8 is presented a plan with the chimney removed and a duplex fan substituted. This duplex fan is in effect two fans supported upon beams above the space between the economizers. Each fan is provided with a direct connected engine, and both deliver the gases into a common stack extending a short distance above the roof. No valuable space is occupied, and that upon

which the chimney stood is rendered available for other purposes.

The fans are each of such a size and capacity that either is capable of producing sufficient draft for the entire plant. An arrangement of dampers between the fans and in the outlet connection make possible the stopping of one and its internal inspection without interfering with the other. By means of a special form of draft regulator the fans are kept continuously in operation at just the speed necessary to produce the draft that, with different conditions of the fire, will maintain the steam pressure constant.

A comparison of relative first cost under the two conditions as shown in Figs. 7 and 8, is as follows:

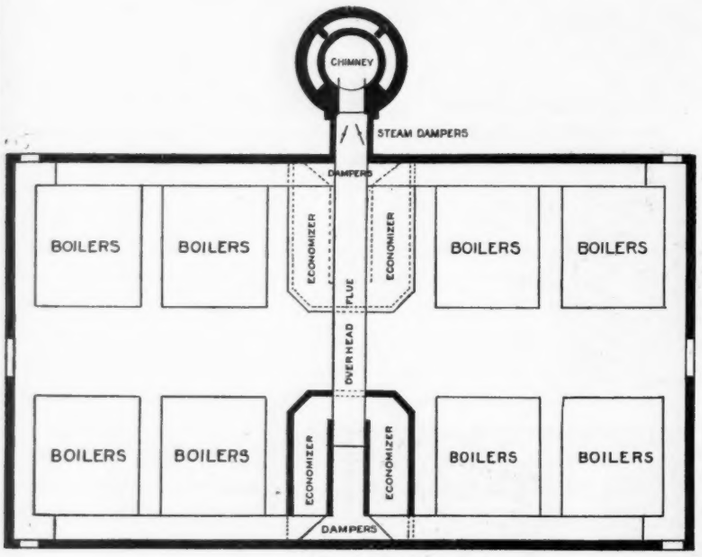


FIG. 7.

Chimney Draft.		Mechanical Draft.		
Cost of chimney.....	$16,000	Cost of fans, engines, draft regulator and short stack, installed complete..	$5,000	
Cost of damper, regulator and dampers...	500	Saving by use of mechanical draft.....	11,500	
	$16,500			$16,500

The mechanical draft plant is thus shown to cost only about 30 per cent. of the arrangement with the chimney, and this is when there is in reality a duplicate or relay fan. Under mechanical draft the boilers can easily be operated above their rated capacity, and it is therefore perfectly reasonable to consider the saving which might result from reducing this plant by two boilers, making the total number 14 and calling upon each to operate at about 14 per cent. above its rated capacity. Only 2,800 nominal horsepower of boilers would thus be required to be purchased and installed, and the building itself would be reduced in size and cost. A saving of about $8,000 can thus be made in the first cost.

As regards the operating expense, this should in any well-established plant be practically nil, for the exhaust steam from the fan engines would be utilized for heating feed water in buildings. Although in a small plant the percentage of steam required to operate the fan may be as high as 3 per cent. of that generated by the boilers, in the above case the fans should be operated with only about 1 per cent. of the output of the boilers.

Economy in feed may be secured as the result of the influence of several factors. Prominent among them is the increased rate of combustion which may be secured with mechanical draft. Not only does this increase the output of the boilers, but, as already shown, it is conducive to economy in the processes of combustion, less air being required per pound of fuel with the higher rate. For with the thicker fire necessary for a more rapid rate of combustion, the air comes into intimate contact with a larger amount of fuel. More efficient combustion means economy in the quantity of fuel consumed, with consequent reduction in the total cost of handling. Upon shipboard the matter of quantity is of great importance. Thus, suppose that for a steamer of 2,500 tons dead-weight capacity 300 tons of coal are required for an Atlantic passage, with ordinary draft. A saving of 20 per cent. of fuel as the result of adopting mechanical draft would mean an increase in possible weight of the cargo of about 60 tons.

But even more important under many conditions is the ability to utilize cheap fuels. It has already been shown that in the case of a boiler plant of about 1,000 horse-power an actual saving of $126 per week was made in the coal bill by introducing mechanical draft and using a much cheaper grade of fuel. It has also been shown that the intensity of draft produced by mechanical means is absolutely necessary to the successful burning of the low grade refuse coals like buckwheat and rice.

The economy of space which results from the introduction of mechanical draft is most important in its influence on shipboard, for every foot saved means just so much more for coal and cargo. The following estimate has been made of the items of saving under forced draft in the case of a transatlantic liner:

ON ROUND VOYAGE.

Cargo, weight and measurement 1,600 tons.....	$20,500
160 first and second-class passengers, less cost of food	8,000
80 third-class passengers, less cost of food.....	1,200
Total for one round voyage.....	$29,700
Total for ten round voyages.....	297,000

The actual results with natural and forced drafts in the case of a large number of steamers is shown in Table No. 25, which serves to make clear the economic advantages of the latter method of producing draft.

TABLE NO. 25.

AVERAGES.	Number of Steamers.	Heating Surface. Per I. H. P., in square feet.	Heating Surface. Per pound of coal per hr., in sq. feet.	I. H. P. per square foot of grate.	Coal burned per sq. ft. of Grate per hour, in pounds.	Coal per I. H. P. per hour in lbs.
For all steamers.....	28	3.275	2.14	11.22	17.08	1.522
For natural draft.....	22	3.560	2.25	8.91	13.92	1.573
For forced draft.....	6	2.412	1.72	20.98	28.15	1.336

The relative efficiency of the fan and the chimney as means of moving air is such that the utilization of the heat in the waste gases which is possible with the former means forms one of the most important economic advantages of mechanical draft. In other words, the fan is essential in any satisfactory application of air heaters, feed-water heaters or economizers. The average of a series of comparative tests of boiler plants equipped with economizers and mechanical draft showed an average saving of heat of about 15 per cent. Efficient draft can be produced with the fan when the gases are leaving the economizer at less than 200 degrees, a feature impossible of accomplishment with any ordinary chimney.

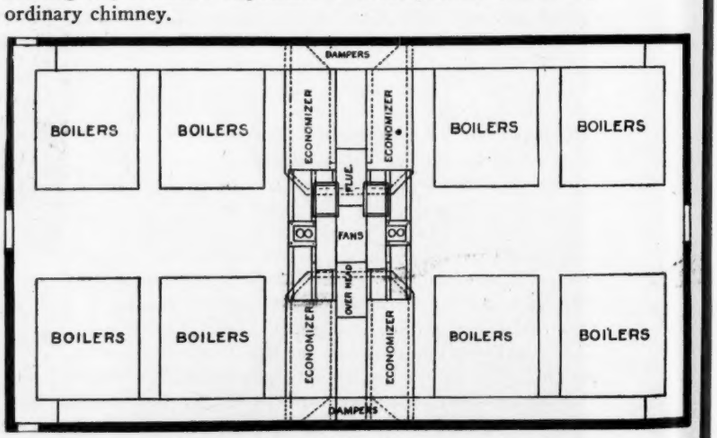


FIG. 8.

Another appliance made distinctly more serviceable with mechanical draft is the mechanical stoker, because of the intensity and steadiness of the draft which is produced. Not only can the draft be easily regulated to meet changes in the rate of stoking, but it is capable of responding even more quickly than the stoker to a demand for increased evaporation.

Although usually a mere incident to the application of a fan, yet the prevention of smoke by this means is in many cases one of the most important advantages of mechanical draft, to be measured not so much in dollars and cents as in the privilege of continuing the use of boilers in a community where the smoke-

prevention laws are enforced. The thoroughness with which the oxygen is supplied to the fuel and the intensity of the draft are essential factors in this special advantage.

One of the strong claims to superiority is the perfect adaptability of a fan to the production of draft under widely differing conditions. While the chimney required certain fixed and practically unalterable conditions for its location and erection, the fan as employed for mechanical draft may be so adapted as to meet the requirements where space is limited, where excessive pressure is required, where the most perfect control is necessary, or where increased steaming capacity is an absolute necessity. Under no circumstances can the cost of the foundations necessary for the

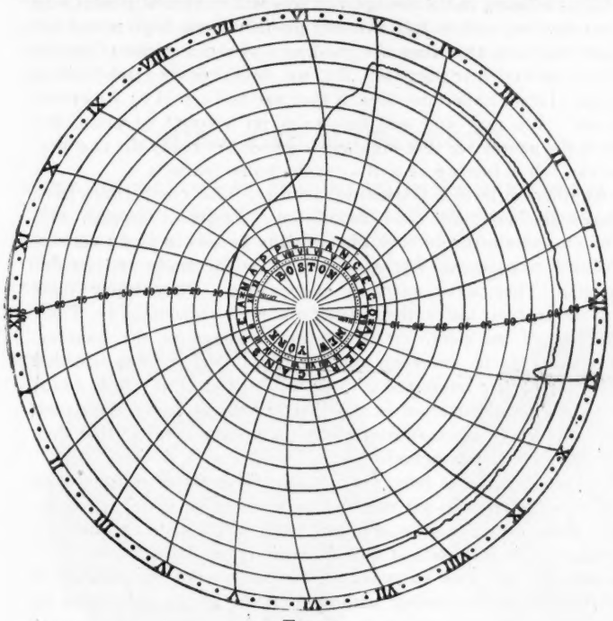


FIG. 9.

proper installation of a mechanical draft plant be compared with that for a chimney, and in most cases otherwise waste space like that above the boilers may be utilized without special foundations.

While with a chimney increase of capacity is a practical impossibility, with a fan, on the other hand, increased intensity of draft and corresponding steaming power of boilers may often be secured by merely lengthening the cut-off on the fan engine. The peculiar adaptability of the fan to the assistance of a chimney is of great importance, for by its use many a plant weak in chimney power has been brought up to the requirements.

While with the chimney the draft must always be produced by suction, in the case of the fan both forced and induced draft are available, according to the requirements of the case. The fan may be driven at exactly the speed adapted to the most economical operation of the boiler plant, and may be instantly, and, if desired, automatically adapted to other conditions. Such control in the case of chimney is dependent upon the operation of the dampers, which restrict the flow of air and gases, but with a given temperature do not affect the intensity of the draft. Proper control of a fan consists in so regulating its speed—usually with dampers constantly open—that not only are changes produced in the air volume moved, but the pressure is varied in such degree as to overcome the resistances. That is, to maintain constant steam pressure the draft must be variable. This is most clearly shown in the accompanying reproductions, Figs. 9 and 10, of charts coincidently taken from a recording steam gauge and a draft recorder applied to a boiler plant equipped with mechanical draft. The sudden and considerable changes in the draft serve to offset any slight tendency of the steam pressure to rise or fall more than a pound above or below the standard pressure.

With a chimney the intensity of draft depends upon the intensity of the fire and is, therefore, least when the fire is low, which is usually the time when it is most required. With the fan on the other hand, it is possible to instantly produce practically the maximum draft under these conditions. It thus becomes entirely independent of climatic conditions, and the influence of damp and muggy days is eliminated. This feature is of almost inestimable value in electric railway plants, for it is on just such days, perhaps made worse by snow and slush, that the greatest demand is made for power while the electricity is most rapidly dissipated, and with a chimney is least readily met. The positive character of the fan, which is thus displayed, renders it available at all times and independent of all external influences.

The amount of air handled by a chimney can be restricted by dampers, but the intensity of its draft is fixed by its height and cannot be changed to suit the conditions. The fan, on the other hand, being under constant control, is thoroughly flexible as to both volume and intensity of draft. The chimney, in its very stability, is the opposite of flexible. The ready flexibility of the mechanical draft makes it easily adjustable for the combustion of different kinds of fuel and for widely different rates of combustion, so that a given boiler may be worked under widely varying conditions. Furthermore, it is possible in most cases to largely increase the size of a boiler plant before exceeding the possible capacity of the mechanical draft apparatus.

A brick chimney, once erected, is a fixture, considering the difficulty and expense of its removal. As a consequence, the only result in the case of change of location, is to leave the chimney as the buildings are left. This holds true even if the boilers are only removed to another portion of the same works. The chimney must remain, frequently as a monument to an abandoned industry. On the other hand, a fan with accompanying engine are always portable; they may be removed to another part of the works, or to a distant place, with almost equal facility, and not infrequently may be set up again under decidedly different conditions.

Closely linked to and dependent upon the feature of portability is the facility with which a fan previously employed for draft production may be sold, not, of course, at its original price, but, particularly in the case of small fans complete in themselves, at a price worthy of consideration alongside of the continually fixed charges upon a chimney that has been abandoned.

As an incidental in the installation of mechanical draft on shipboard, the ventilation secured under certain applications is a feature of marked importance, serving as it does to reduce the intense heat of the fire rooms.

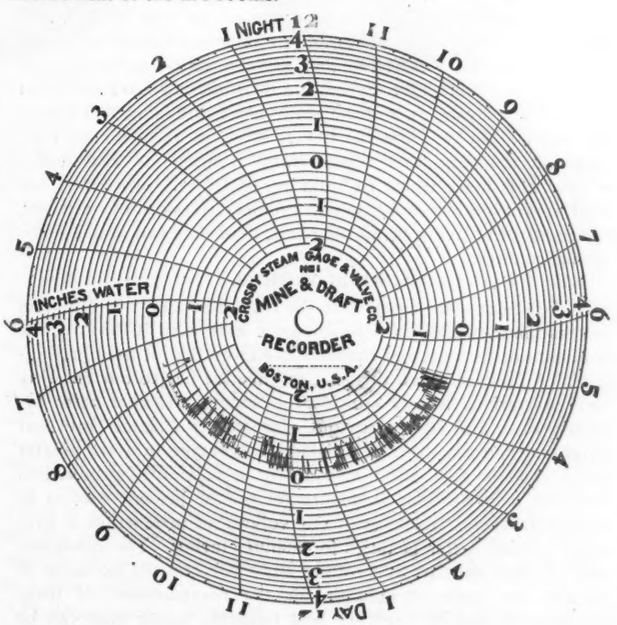


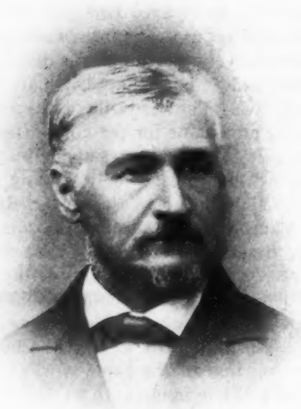
FIG. 10.

To a great extent many of the advantages which have been here presented are interdependent; the possession of one advantage being evidence of the possession of others of similar character. Thus the very adaptability of mechanical draft is indicative of the fact that it is more flexible than that produced by a chimney, is more readily constructed, and less influenced by climatic changes; while the apparatus for its production is more readily transported and a higher potential value than a chimney. To a considerable extent these stand out as the conveniences of this method regardless of their economies. When it is shown, as in what has preceded, that increased efficiency can be secured by a method that is more convenient, the advantage of mechanical draft is established.

FOREIGN TRADE.

ITS POSSIBILITIES FOR OUR MANUFACTURED PRODUCTS.

JOHN A. JOHNSON.*



Having spent considerable time in Europe during the last few years, and also having been one of the delegates to the Republics of Brazil, Argentine and Uruguay, as representative of the Association of Agricultural Implement and Vehicle Manufacturers of America, in 1896, the question of the prospects of our export trade has, of course, come within the scope of my observations. My report on our trade relations with South America treats more extendedly of our prospective trade with the countries visited than is possible in this brief article. (This report will be mailed free of charge to those who may apply for it to the Gisholt Machine Co., Madison, Wis.)

In a discussion of this subject the first, and we may say the main question is as to the natural resources and facilities of this country for manufacturing, as compared with those with which we may compete. I unhesitatingly affirm that we have greater natural resources and better natural facilities for manufacturing than any present rival. Our ores are more abundant and more easily mined than those used by competitors, and, as a rule, are of better quality. We produce the king of fibres, cotton, in much larger quantities than we consume. So with lumber. Of the great staples for the workshop, we import, or need to import, only tin, rubber, silk, wool and some of the coarser tropical fibres. Our facilities for assembling the materials are better than those of our rivals, as we have many navigable lakes and rivers, and aside from this, the country is level, so that railway construction is cheap, and consequently freights are reasonable, as are lands upon which to build our factories. Moreover, our food products are cheaper, so that the operatives can live cheaper, the standard of living being the same, than they can in any competing country.

LABOR HIGHER.

A single item that enters into the cost of products, and a main one, is labor, which costs much more here than it does on the continent of Europe, and considerably more than it does in England. A few years ago this was an effective bar to our entering foreign markets to any considerable extent. Higher rates for money have also been a serious obstacle. But aside from our natural resources, we have a decided advantage in a far greater home consumption, and consequently in volume of production. This we may consider as the secret of our present success in foreign markets. Because of our volume of production it pays us to provide better facilities for manufacturing. The consumption of track supplies and rolling stock for our 182,000 miles of railway has made it possible for the manufacturer of these products to provide the very best facilities, better than can be found anywhere else. So, also, water and gas pipe, which are now being shipped even to London.

It has been asserted that these superior facilities are due to the greater inventive genius of our people. This is not true. The higher price of labor is one factor in our superior labor-saving machinery, but the more important one is the great volume of production.

KNOWLEDGE OF THE MARKETS NECESSARY.

We are laboring under great disadvantages in our want of knowledge of the requirements of foreign markets. We are prone to forget that the foreign consumer has been trained in the use of foreign made goods and that he may have preconceived notions and tastes that have to be met or overcome by convincing him that our goods are superior. In either case education is required, and this takes time and money. America has been for many years the source of supply of food products. In these the channels of trade are established and well known, but not so as to the products of the factory. Our manufacturers must seek the foreign markets. Men well qualified to represent the goods, who are acquainted with the language of the people among whom they are to labor, should be sent as salesmen. We need a good school to educate such salesmen, as they can very much more quickly acquire at least the rudiments of the necessary knowledge in the school than in the field of actual work.

Our salesmen in the foreign markets will continually meet one obstacle: they will be told that our goods are too high priced for those markets, that they are used to a cheaper grade of goods which answer their purpose. But we should never send inferior goods abroad under any plea, if they are to be sold as American goods. We may and will lose sales on account of price, but when the people see that high grade goods are really the cheaper, we can sell in foreign as well as in the home markets.

Another obstacle is marketing facilities. Our competitors have an established trade and reputation. English, German and French manufacturers have old, wealthy houses in every considerable foreign city. These houses know the trade and its demands. They have agencies everywhere. They know their customers, their tastes, their wants and their responsibility. Their commercial travelers, versed in the language of the country, visit every part. Banking and exchange facilities are afforded either by parties interested with them directly, or as fellow countrymen. Transportation is afforded in vessels under their own flag, the vessels often subsidized by the government, so that they carry freight below actual cost.

As yet Americans have very few of these facilities, generally none. They have as yet sent out very few commercial travelers, and most of those that are sent must sell goods through an interpreter if they sell at all. They have no large commercial houses of their own to speak of, but must work through those established by competing nations, and the goods sold must be transported under foreign flags. Banking and exchange must be conducted through foreigners. The marvel is that under such adverse conditions we secure any foreign trade at all.

THE WARES IN WHICH FOREIGN TRADE WILL MOST RAPIDLY INCREASE.

Foreign demand for our railway supplies has but barely commenced. Of course there is a limit to this demand. We ourselves own half the railroads of the world and half the demand for supplies is here at home. But the superiority of our iron and steel and their low price is only beginning to be known. A largely increased trade may therefore be confidently looked forward to.

Because of the cheapness of ship building materials we ought to have a large export trade in ships, and there is no doubt but that this industry will rapidly increase. The great drawback is that our ships are hardly ever seen in foreign ports. But few foreign nations have good ship building facilities, and can buy ships cheaper than they can import materials and build them. There is a promising future for this great industry. In cast iron, bar iron and steel, wire, nails, in all the heavier iron products, there is bound to be a greatly increased trade.

In the higher grades of tools and machinery I do not look for a correspondingly large demand because of our higher price of labor. The Englishman, the German and the Frenchman can more readily compete in this field. The past year or two there has been a very large demand for bicycle machinery. This demand will soon be decreasing. Again, if we build superior tools foreigners soon copy them. In high grade machine tools there must always be a comparatively large amount of hand labor which tells against us. Still, we should certainly continue to export such goods, I hope, in increasing quantities, but not in proportion to coarser products.

In paper, especially print paper, we ought to have a large export trade, and with proper effort will have. Large margins must not be looked for. But paper is now cheaper here than in Europe, because of abundant timber, great water powers and cheap transportation.

In the textile industries the outlook is not so promising. In the finer products the foreigner has yet the advantage, especially in thoroughly trained operatives. But in cotton we have a little the advantage, and in the staple cotton goods we can compete

* President of the Gisholt Machine Co., Madison Wis.

now. But it is merely a question of a few years when we shall have a fair share of foreign trade also in these higher grades.

A word of warning to our manufacturers may not be out of place. There is a great temptation to lower the standard of American wares in order to meet the prices of competitors. Better to let the trade go than to put out inferior goods. In the long run there is no money in poor goods. Better make only good wares and hold prices accordingly.

All goods should have the name and address of the manufacturer so as to build up a trade name. The government should, as far as possible, arrange by treaties with foreign nations to protect honest manufacturers in trade marks and trade names, and Consuls should be instructed to expose the fraudulent use of American brands on foreign goods. Such frauds are now extensively practiced. Foreigners copy American goods and advertise them as American.

* * *

UNDER THE MICROSCOPE.

SOME SNAP-SHOTS AT SPECIMENS OF MACHINE WORK.

Mr. Thomas P. Whittier, of Rochester, N. Y., has constructed an apparatus for photographing microscopic objects by an instantaneous exposure, and believes that he is the only one to accomplish that result.

FIG. 1

He obtained his first successful negatives in April, 1895, and Fig. 1 is a reproduction from a specimen of his work. It represents muscle—which often predominates in a shop because it is supposed to be cheaper than brains, and in one sense of the word

FIG. 4.

it is. The view is taken parallel to the grain and is magnified about 175 diameters (as shown in the cut).

Snap shot cameras have become so popular that some of the advantages of his invention over a method that would require an exposure of minutes, or possibly hours, will be readily understood; but one point that he calls particular attention to is that by an instantaneous exposure it is possible to obtain a distinct photograph of an object so small that if taken by a time exposure it would be rendered invisible or blurred by imperceptible vibrations, the effect of which it is impossible to overcome by any other method.

He is confident that his invention will enable him to supply a superior article at comparatively small cost, and expects to see it become popular with the professional classes, schools, colleges, etc.

Mr. Whittier uses a wet plate for most of his work, and I was permitted to see him make several negatives. His apparatus is not patented, as he has more faith in secrecy than patents. There is much of interest that could be written on the subject, outside of

FIG. 5.

the secret points; but as this journal is devoted to articles of a different nature, I will leave those who are interested to secure further information from the inventor himself.

I found that he did not hesitate to grapple with anything in the shape of a photo-micrograph, so I secured a brand new Brown &

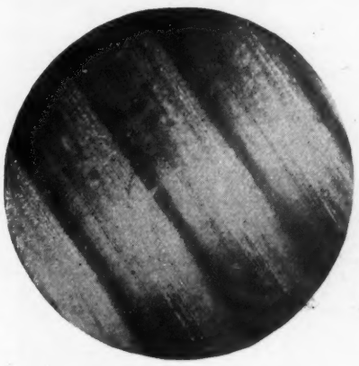


FIG. 2.

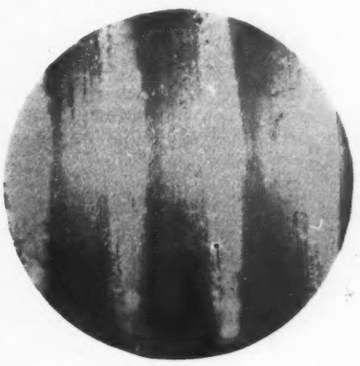


FIG. 3.

Sharpe micrometer, purchased a dozen common 36-pitch machine screws, which correspond nearest to the 40-pitch screw in the micrometer of any that I could find in stock, and had him make the negatives from which Figs. 2, 3, 4 and 5 were taken, after selecting one of the best screws in the dozen for him to work from.

These specimens were selected because they were the most easily obtained—no doubt the same results would have been obtained from other screws, and as regards commercial accuracy they afford an interesting comparison.

Machine screws like the ones shown in Figs. 3 and 5 are good enough for ordinary purposes; are commercially good at least, and sell as an interchangeable article at commercial prices—3 cents per dozen, or 16 cents per gross, at retail. It is safe to say that they are cheaper and better than the old hand-made screws and they could be made as perfect as the micrometer screw, Figs. 2 and 4, and they would be, too, if it was necessary, but how much would they cost? Would they cost any great amount more than the old hand-made specimens that had a head about as round as a good ellipse?

In regard to the illustrations: Looking straight down on the surface of the micrometer thread with a microscope magnifying it about 30 diameters, it looked like Fig. 2, only the cut shows the negative reduced to about two-thirds size. Fig. 4 is looking by the side of the screw, showing the threads in profile magnified about 70 times, and in Figs. 3 and 5 the same views and relative sizes of the machine screw are shown. A, L. G.

* * *

It is reported by the American consul at Gibraltar that there are about fifty bicycles in use at that noted stronghold, but that he "sees no prospects for any increase." As about half of Gibraltar is a precipice and the other half is all hills, we presume the prospects will be for a decrease after they get over the fever—the bicycle fever.

"BURNING IN" BRASS CASTINGS.

C. VICKERS.

Whenever in the brass foundry a heavy casting is found "drawn" at the gate, or a large thin one with a small hole or "cold shut," the invariable reply of the molder to the "kick" of his foreman is: "Never mind, let me burn it in; I'll fix it all right," and if the man knows his business he is usually as good as his word, and if he doesn't he will spoil the casting. Probably it is this latter fact that has caused the burning-in business to be looked upon with such disfavor in some shops. Of course, the causes which lead to the necessity of burning in are to be deplored, but as it is "human to err" we may reasonably expect such things to occur from time to time, and, when they do, it is a good thing to know how to remedy them. In the case of the heavy casting aforesaid, the job of burning-in may be easy or otherwise, according to the nature and size of the cavity.

Sand holes are the easiest to burn, as all the preparation that the casting needs is to scratch out the sand from the hole and expose the clean metal underneath. In many such cases the preparatory treatment can be quickly accomplished by grinding the spot out on an emery wheel. But in the case of a draw or blow-hole, the writer has found by experience that, in the majority of cases, such elementary treatment is insufficient. If the cavity is so small that it can be ground out, it is all right; but if it is deep this cannot be done. We may pour any amount of metal on, but in few cases will the burn be solid.

I have known instances when the burning was repeated half a dozen times and was then unsuccessful. Every time the surplus metal was ground off, the same old "worm" hole would appear, and by probing you would find that it corkscrewed way down into the casting. These troubles can be easily prevented however.

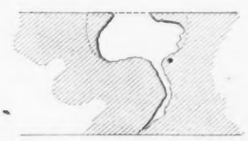


Fig. 1

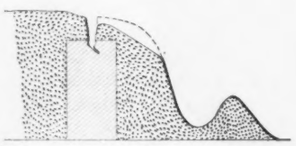


Fig. 2

First chip out the top of the overhanging cavity, as shown in Fig. 1, after which plug the "worm" holes with pieces of brass; vents are good for this purpose, and they must be pounded in solid with a blunt punch. I have also had good results by filling the entire cavity with wax, and burning out, but I believe the plugging method is the surest. This preparatory treatment of the casting may look simple, but if neglected it often leads to a world of trouble. The burning in itself is very simple. The casting is merely bedded in the sand pile, or in a flask, as circumstance dictate, and a suitable piece of wood or core is placed over the spot where the burn is to be, and sand packed over the casting, all around it, to a depth of, say, one inch. The piece of wood is then withdrawn and all dirt blown out of the hole, after which a space is provided for the overflowing metal. Fig. 2, which is in section, explains the operation. In the case of a hole in a thin casting, the best method is to fill up the space with wax, smoothing it with a heated tool until it is level with the rest of the casting, after which it may be prepared for burning as above. The sand must be carefully tucked around the castings, especially under where the new metal is to be added. In the case of a large thin casting, weights must be placed thereon to prevent springing, and a very little metal must be flowed off, otherwise the casting will be cracked. Four or five pounds are plenty on a casting ⅛ inch in thickness. With a heavy casting a considerable amount of metal must be flowed off to make a good job. When it is thought enough metal has been used, wait a moment and look for signs of bubbling; if the metal lies quiet, the job is completed; if not, more metal must be poured over. If the bubbling still continues after this has been tried two or three times, the burn is a failure, the casting must be removed from the sand and the trouble located. When the casting has been well plugged, as recommended above, the difficulty will be caused by moisture condensed from the sand. In such a case the casting must be well dried before again bedding in the sand. A little kerosene dropped on the "burn" will always prevent this trouble.

The cases just illustrated are only simple forms of burning. Sometimes, in castings that have a flange united to the body by a comparatively thin neck, the neck will crack in cooling. Usually in such cases the defect is not discovered until work has been done on the casting in the finishing shop. If the article is thrown away at this stage the loss will be considerable. This can be saved by burning on a new flange. The cracked flange is removed, and the interior of the casting filled with sand, vented and then dried. The mold is constructed from the pattern in the usual manner, a gate being cut to carry the metal to the flange, and another to take it to a large riser, as shown in the illustration of the whistle stem in Fig. 3. When burning on flanges the gate must be so placed that the metal will acquire a rotary motion in the mold, and so come into contact with and cut away all portions of the protruding stem, thus insuring a solid union. The mold must not be closed until ready to pour, just previous to which the broken casting is placed in position. The metal must be poured hot. In a certain shop in which the writer was at one time employed, the disc on the stem of the whistle was worn out, or broken, I forget which. As this whistle was large, to save the expense of a new one, they determined to cast another stem. The old one was waxed up and a casting made from it, but was useless, because, as they had no tools to cut the thread on the stem they had cast it,

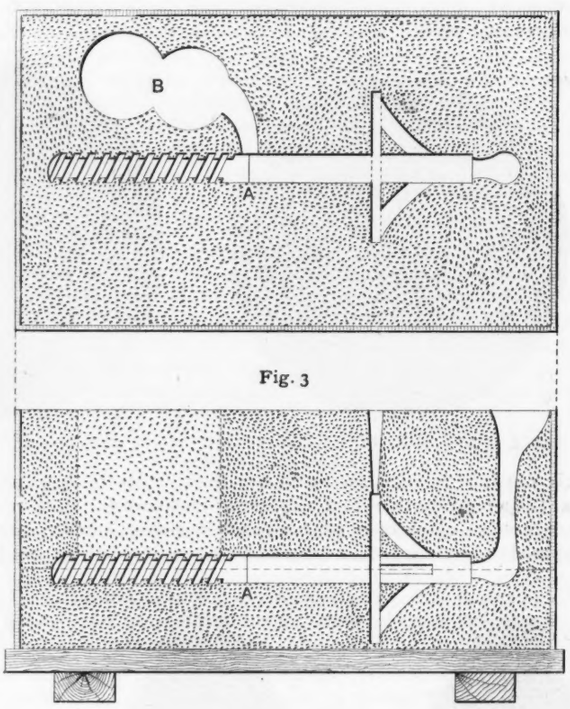


Fig. 3

and the shrinkage made it too small. As this was one of those shops where they did not practice burning, the idea would never have occurred to them. One of the molders mentioned it, however, and after explaining how it could be done, was allowed to try. He made a mold from the old stem, and after drawing the pattern, cut off the threaded portion, as shown at *A*, Fig. 3. At this point a gate was cut, communicating with a very large riser *B*, which was cut through the cope. When all was ready for pouring, the threaded portion, which had meanwhile been kept in a warm place, was placed in its proper position in the mold, which was then closed down, and poured in the usual manner. When the metal in the riser was congealed, it was broken out and returned to the furnace again. The casting when taken out was all that could be desired. By modifying the above process, a casting of brass can be made of different colors, by burning red brass on to yellow, and yellow on to copper, and the shades can be varied indefinitely according to the mixtures used.

* * *

It is claimed that a steel tape was exhibited at a recent Scandinavian exhibit, made of cold rolled Swedish steel, which was 8 inches wide, 2,354 feet long and weighed 1,146 pounds. It was not stated in how many pieces it was made, and we do not wish to be held responsible for the story.

A NEW SHOP SYSTEM.—1.

GEO. D. CHAPMAN.

The system hereinafter described has demonstrated its many advantages, having been in active operation for the past two years at the shops of the Fitchburg Machine Works, Fitchburg, Mass., where a variety of tools are manufactured. To be of commercial value, a system should not be complicated; it should not depend upon the presence of any one man, but in a measure should run itself and be so simple and so tabulated that a new man could soon learn to handle it.

By the "old way" there were certain faults which had to be overcome. For example, it was found that if the head draftsman were away it was difficult to ascertain whether a certain drawing had been made or not; the same applied to the patterns, for dependence was placed upon the memory of the pattern foreman. There was also uncertainty in regard to what changes were agreed upon when a particular machine was built. If a similar machine was ordered a year after, the question came, What alterations are necessary, and why; can anyone remember? These troubles occurred frequently with us, and we found the same to be true of other shops; they were the cause of much loss of time and labor, as too much dependence was placed upon the memory of those concerned.

For convenience in describing, this shop system may be divided into the following heads: 1st. The Designs. 2d. The Drawings. 3d. The Patterns. 4th. The Stock. 5th. The Record. 6th. The Shop Working Drawings. 7th. The Shop Costs.

1st. THE DESIGNS.

The designs are made full size, when possible, on "Duplex" paper, and in many cases the details are not worked out. The size of this design sheet depends only upon the size of the machine, as no tracing is made of it, and it is only used for developing the mechanisms and for working up the drawings. This method was found necessary, as the design sheet generally became so defaced that it would have been impossible to trace it.

2d. THE DRAWINGS.

The three kinds of drawings used are called Regular Drawings, Sketches and Lists. The "Regular Drawings" are for regular machines, and consist of tracings which have consecutive drawing numbers in the lower right hand corner, as 1686 shown in the title below. They are made in sheet sizes denominated by the numbers 1, 101, 201 and 301. The reason for these numbers will be explained later; in practice "1" and "301" are seldom used. Sheet size "1" is 30 x 41 inches, this being settled by the prevailing size of tracing paper; size "101" is one-half size "1"—*i. e.*, 20 x 30 inches—and each size thereafter decreases by one-half.

The "Sketches" are drawings which are to be used but once and are made in pencil, to scale or free hand as the case may require, on block paper 8½ x 11½ inches (this being a standard size sold by paper manufacturers), and by inserting a carbon sheet a duplicate is always produced, which is filed in the drawing room. These "Sketches" have consecutive sketch numbers in the lower right-hand corners, as S—141.

The "Lists" are tracings in ink of specifications, sizes, castings, etc., and have consecutive list numbers in the upper right-hand corner, as L—251. These lists are made in sheet sizes number "301," "401" and "501," following the same rule in regard to proportionate size as the Regular Drawings.

In preparing the "Regular Drawings" simplicity is the aim. Black ink only is used; there are no shade lines; the section lines are standard for different materials, and the dimensions are given only for finished surfaces. Stamps are used for lettering in the title and wherever possible, to save expense. A "Bureau of Information"—that is, a "List" giving information—is posted in every department, so that the significance of abbreviations such as C. I., cast iron; Comp., composition metal, etc., may be understood.

DRAWING DETAILS.

Changes are made upon the drawing tracings from time to time, and either a blueprint is taken and filed in the same folio as the original drawing—in which case "B. P. Filed—7—21—'97" (date) is printed upon the tracing—or, if the change be slight, as a dimension, the original figures are crossed and new dimension put on, as "¼" after 7—30—'97."

The following is a title as it appears on a "Regular Drawing" in the lower right corner:

GEM.

FITCHBURG MACHINE WORKS.

13 L.

"Chapman Duplex" feed.

Cast Iron Details.

Full Size. April 27-'97.

Sheet 219. **1686**

[The "Sheet 219" in the above shows the drawing is on 200 size sheet, and the "19" indicates that this is the 19th drawing in its folio.]

PIECE NUMBERS.

Each and every piece of a machine is given a piece number, which is put upon the drawing in a ⅝-inch circle. These numbers are systematically arranged according to class of machine, kind of material and number of piece. The class of machine is designated by numbers and letters forming a symbol such as "13 L," this designation being explained upon the "Bureau of Information" before mentioned. This particular number means "Gem Lathe, 14 inch." The kind of material is expressed by the kind of number given the piece, this number being placed directly underneath the symbol designating the class of machine (such as the "13 L" above), and both being included within the ⅝-inch circle upon the drawing.

DRAWING CASE IN DRAWING ROOM.

Piece numbers for all castings for each machine start with 1. If the casting be of malleable iron or cast steel an M is added to piece number, the piece number itself coming consecutively among the casting numbers for that machine, as 2 M. This is advisable, as matters are kept much straighter than by taking a new piece number just because the casting may be changed to a different material, the same pattern being used. If the casting be of composition metal or bronze, a C is added, as 25 C. The patterns are always marked with the piece numbers as shown on the drawing.

Steel or wrought-iron piece numbers for each machine start with 001, always having 00 before the number. Miscellaneous pieces, as leather, brass, coil springs, etc., have piece numbers for each machine starting with 01.

The following figures illustrate this method of piece numbering and show how the symbols appear on the drawing. In the first circle the symbols indicate that the piece is number 2, is of cast iron and belongs to machine 13 L; in the second circle the piece indicated is number 25, composition, machine 13 L; in the third, number 45, steel or wrought iron, machine 13 L, etc.

This system of piece numbering serves the triple purpose of (1st) distinguishing readily between the different machines by the class number (this makes the numbering and finding of patterns and the cost keeping of stock and labor easy); (2d) determining the material used, as explained above, which also greatly assists in keeping the costs; (3d) making it easy and simple, in drawing and pattern departments, to number each piece, as numbers for each material for each machine run consecutively. If any piece upon a machine is superceded by a different piece, the new piece is given a new piece number, no number being repeated.

What has been said above regarding drawing details applies both to the "Regular Drawings" and the "Sketches." The details of the "Lists," however, must necessarily vary with the subject to be listed.

DRAWING INDEXING.

In the drawing room there is a suitable case with various sizes of drawers to receive all drawings, the drawers being numbered and labeled. The labels are made upon a tracing, a "List," and blueprints are taken and inserted in the label holders on each drawer. The drawers containing tracings and sketches have the reverse blueprint label—that is, a blueprint of a blueprint, giving blue letters and white background; the drawers containing blueprints (these are such prints as are not needed in the shop at the time) have the regular label—that is, white letters and blue background. In this way the contents of the drawers can be quickly seen.

The drawers contain heavy brown paper folios for drawings, made flat, folded once, making a cover under and over the drawings only. The drawings are kept flat, not rolled. Each folio has a folio number in the front right-hand corner, and in the front left-hand corner a card for keeping track of the sheet numbers; as each drawing has a sheet number running consecutively through the folio and starting with "1," "101," "201," etc., according to the size of the drawing. This is the reason that a different hundred is taken for each size drawing.

A blueprint label indicating the class of drawings enclosed is pasted in the center of the front of each folio.

One drawer is divided to hold "library bureau" index cards, part being "title indexed" and part "number indexed." The cards are all 3 x 5 inches, standard ruling; but of various colors for different purposes.

To explain the system by which these cards are made out, and the purposes for which used, it will be necessary to explain the cabinet in the engineering office and the orders given for drawings.

The engineering office cabinet contains sixty-eight tills, some thirty of which are used for notes on machines, one for each tool. These notes are of such changes and alterations as have been found advisable, with reasons for same, each note being dated. In each "machine till" there is also an envelope containing orders which have been returned for "Drawing done," and one for "Patterns done," which relieves the memory and makes a check upon the work, while at the same time it shows the date when the changes were made.

DRAWING ORDER.

JONES.		4-20-'97.
No. —.		
Size 201.	13 L	
Date, ——.	"Chapman Duplex" feed.	
	C. I. Details.	

[This order is written in pencil, and is made in duplicate by means of carbon paper.]

Orders are written for all drawings or patterns in duplicate, by the use of carbon paper, for a particular machine ordered to be brought up to date, changed or made new. The orders are never made out, however, until the notes in the till referring to said machine have been inspected. The orders are put in the till labeled "Drawing Requisition" or the one marked "Pattern Requisition," as the case may require a drawing change or only a pattern alteration; if a drawing change be required, the pattern order, of course, is not made out until the drawing is changed. If the machine ordered be new, the design is first made, and then all drawing orders written for the details, the same as for changes.

ENGINEERING OFFICE CABINET.

The work is in this manner kept "on tap" for draftsmen and pattern makers.

The process of work in the drawing room is as follows: The original order (drawing order explained above) is given to the draftsman, and the duplicate is filed in the till labeled "Draftsmen." This original order is returned to the engineering office when the drawing is done, checked and approved, by the head draftsman; the duplicate order is then checked.

DRAWING ORDER AS IT IS RETURNED TO OFFICE, ENGINEERING DEPARTMENT, SHOWING PATTERNS TO BE MADE.

JONES.					4-20-'97.
No. 1686.					
Size 201.		13 L			
Date, 4-22-'97.		"Chapman Duplex" feed.			
		C. I. Details.			
New pat.	13 L	13 L	13 L	13 L	
	64	92	Change 65	66	
13 L		Brass pat.		13 L	
67				379 C	

PATTERN ORDER.

SMITH.				4-22-'97.
		13 L		
		Feed, C. I, Details.		
13 L	13 L	13 L	13 L	13 L
64	62	Change 65	66	67
		Dr. 1686.		

[This order is written in pencil, and is made in duplicate by means of carbon paper.]

The pattern orders are made out as shown herewith from the specifications and pattern numbers returned on the drawing order as it comes from the drawing room, as shown by the cut above. No reference at all is necessary to the drawing itself. These pattern orders are put into the "Pattern Requisition" till to await the pattern department.

The original order is then given to the drawing-room clerk, who follows the rules given below for indexing "Drawing," "Sketch" or "List," getting all his data for the cards from the above order.

RULES FOR INDEXING.

COMPLETED DRAWING.

1—If drawing supersedes, stamp and mark date and drawing number on superseded drawing and add A to sheet number.

2—If drawing supersedes, ditto on "title index" card. Put this card in superseded division, which is arranged back of others, in proper "part."

3—If drawing supersedes, cross superseded number on "number index" card.

4—If drawing supersedes, erase superseded number on "record" sheet.

5—Add drawing number to "record" sheet.

6—Mark "class" and "part" on "number index" card.

7—Make out new "title index" card and use vacant sheet number, if any.

8—Mark sheet number on drawing.

9—Change vacant or next sheet number on folio.

10—If drawing supersedes, destroy superseded blueprints in shop and drawing room if not in use.

COMPLETED LIST.

1—If list supersedes, stamp and mark date and list number on superseded list and add A to sheet number.

2—If list supersedes, ditto on "title index" card.

3—If list supersedes, cross superseded number on "number index" card.

4—If list supersedes, erase superseded number on "record" sheet.

5—Add list number to "record" sheet.

6—Mark "class" and "part" on "number index" card.

7—Make out new "title index" card and use vacant sheet number, if any.

8—Mark sheet number on list.

9—Change vacant or next sheet number on folio.

10—If list supersedes, destroy superseded blueprints in shop and drawing room.

COMPLETED SKETCH.

1—Mark "class" and "part" on "number index" card.

2—Make out new title index card.

3—File duplicate sketch until original is returned.

After the above rules have been executed, the drawing order is returned to the engineering office, the duplicate is destroyed and the original is filed in an envelope marked "Drawings done," in the proper "machine till" in the cabinet—"13 L" till in this case.

Examples are here shown of index cards for the Gem Lathe, 13 L.

DRAWING "TITLE" CARD.

1686	60 97	12	Sheet 219
4-27-'97	13 L	"Chapman Duplex" feed. C. I. details.	

"Title" index, white, for drawings. "1686," drawing number. "60"—"97" means drawer No. 60, folio No. 97. "12" signifies the "part" of machine to which the drawing refers—in this case the "hangers, rod and screw."

DRAWING NUMBER CARD.

1681	8	13 L
2	8	13 L
3	8	13 L
4	8	13 L
5	12	13 L
6	12	13 L
7	5	16 L
8	12	13 L
9	4	13 L
1690	4	13 L

"Sheet 219" signifies the nineteenth sheet in that folio (folio No. 97), the 2 preceeding the 19 being significant only of the size of the drawing (20I size). "4—27—'97" is the date of the drawing. "13 L" is the "class" number. The remaining lettering is self-explanatory.

This card is put into the "title" index, behind 13 L guide card, in "part 12," and directly behind the next largest drawing number in that "part."

"Number" index, salmon. The card contains ten numbers, running from "1681" to "1690," inclusive; the first column for drawing numbers, second for "part" of machine, third for "class" of machine.

This card is placed numerically in the "number" index, under drawing division. This division is also provided with "guide cards."

DRAWING "TITLE" CARD, SHOWING SUPERSEDED MARKING.

1685	60 97	12	Sheet 229 A
4-26-'97	13 L	Head hanger. Superseded, 7-12-1897 By No. 1712.	

The above card shows a drawing "title" index card marked by "Rules for Indexing," and by referring to "number" index card above, it will be seen that this number, "1685," is crossed.

LIST "TITLE" CARD.

L-330	63 98	12	CASTINGS.	Sheet 534
4-27-'97	13 L	"Chapman Duplex" Feed.		

"Title" index, salmon for lists. (Otherwise the same as drawing "title" index card.) This is put into the "title" index same as drawing card, except it starts the "part" and forms thereby a guide.

LIST NUMBER CARD.

		L
L-321		List misc.
2	Misc.	13 L
3	14	13 L
4	2	13 L
5	2	12 L
6	18	13 L
7	8	13 L
8	8	13 L
9		1 D
330	12	13 L

"Number" index, blue. (Otherwise the same as drawing "number" index, except placed in list division.)

SKETCH "TITLE" CARD.

		13 L	
S-332	55	Rack pinion gear and friction disc	8- 3-'97
333	"	Gear and cone gauges	8- 5-'97
334	"	Jig leg and bed bolt holes	8- 4-'97
335	"	" L. H. trip lever	8- 5-'97
337	"	Nut stud and eccentric lever	8-11-'97
338	"	Jig nut slides	8-12-'97
338	"	" " babbitting	8-13-'97
340	"	Dummy head	8-17-'97
346	"	Spindle	8-30-'97
347	"	Jig worm bracket facing	9- 8-'97

"Title" index, blue, for sketches; ten numbers to a card. Referring to card shown, the first column is for sketch number and the second for drawer number. The balance is self-explanatory. This card is put in the "title" index, behind "guide card" "13 L," and numerically arranged among the blue cards; all blue cards being behind all other "title" index cards in their "part."

SKETCH NUMBER CARD.

		S
S 331		13 L
2		13 L
3		13 L
4		13 L
5		13 L
6		36 P
7		13 L
8		13 L
9		13 L
340		13 L

"Number" index, white. (Otherwise the same as drawing "number" index, except placed in sketch division.)

In the next issue we will consider the other divisions of the subject.

SEWING MACHINERY.—1.

EARLY HISTORY—THE FIRST PATENT—THE PRINCIPLES OF THE CHAIN-STITCH AND LOCK-STITCH MACHINES.

F. W. BRADY.

The writer has undertaken to present some technical information on this subject—believing it to be the first time—to the readers of a mechanical paper. The reason for the neglect of such a valued branch of machine construction is hard to discover: it may possibly be from a misconception of the value of such information to those in other lines of engineering,

The manufacture of the sewing machine has been brought to a point where the methods used fairly represent the highest attainments in points of economical and systematic design, manufacture and interchangeability. These results are not only applicable to these particular machines, but to many others, as we find utilized here nearly every practical motion, all the different degrees of hardening, the varying qualities of cast metal, the cheap production of difficult parts, and a number of surprises in the way of speed.

All sewing machines are comparatively light, but the theoretical combinations of their parts are good, and not difficult to apply in other cases. They have one peculiarity; in each is a different way of producing the same result, involving for each make of machine special tools and jigs for the production of the necessary irregular pieces, and practically an entire special method of manufacture. The "parts" are finished to size, within a half-thousandth of an inch, and this accuracy maintained without the constant use of verniers and micrometers, except those that can be permanently set, as a part of the operation at the beginning of a long period of duplicate work. Occasionally they require reading to make sure of their constancy.

The cost of making must be lowered to a point where, in spite of the necessary "retail" selling expenses (which are greater than the cost of manufacture), the machines will be salable with a profit for all, and still be of reasonable cost to the user. The preliminary experimental work is very expensive, all of the experimental tools, likewise; patents are as difficult to obtain, as the certain results from the mechanisms themselves; so it is no wonder that "trade secrets" exist, for no one feels like presenting to his competitors, gratis, the results of such expenditures of brains and money.

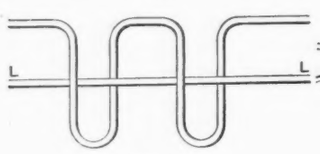


FIG. 1.

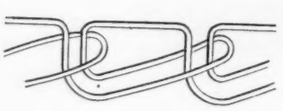


FIG. 2.

The machines of the present day have certainly been advanced to a satisfying degree of perfection, and have fully kept the pace set by other lines of mechanisms, but there is plenty of place for improvements, and always will be, although it is hard to see how, in any but the small details. "Perfect" machines were built thirty years ago, one inventor before that time stating in his patent that he had "perfected" his machine. It is interesting to glance back to the beginning of these machines, that is, to the actual inventing period. The French were the first to be heard from. The tailors there objected so strongly to any substitution of other means to accomplish their work, that they created considerable disturbance, which ended in a genuine eighteenth century French riot. Similar scenes were enacted elsewhere, and it required time and enlightenment to win over the opposition, especially the tailors, who, when realizing that others were profiting by the use of the machines, were forced to adopt them. How true this is, even at present! The people(especially the workmen), who, at first "cry down" automatic machinery, are those who afterward enter most heartily into its progress.

The French government gave sewing machines a good start by its encouragement, really making their use fashionable. It always has done this with French inventions and does so to-day.

The first statement of the actual workings of the modern machines is that they do not "sew"; that is, in the strict and accepted sense of the word. The above mentioned French machine sewed, as some others of a little later period; and this is probably the reason why they were never developed to any extent, except the "Swiss" machine, which produces "hand-work" embroidery. Inventors with practical minds soon realized that the back stitch (as hand sewing is styled), would never be adapted to high speed, and sought other means to make a seam.

The first American to begin the new system was a man named Hunt, who resided in New York. In the '30's he built some machines which did not "sew," with good results. The inspiration for his mechanism probably came from the working of a loom, he trying to "needle" one thread and throw the shuttle by power. The stitch is shown in Fig. 1. The first patents were issued, not to the man Hunt, as would naturally be expected, but to Elias Howe, to whom the honor and perpetuity of name is given. It seems that Hunt was a slow and easy going individual, who couldn't see a good thing when he had it, and allowed Howe to get ahead of him, in 1846, quite a few years after.

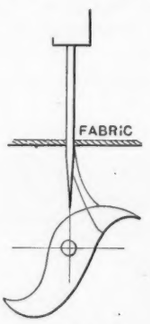


FIG. 3.

FIG. 4.

These early machines were very heavy and clumsy, wood entering into the construction to a great extent, and as labor-savers did not amount to much, although they were used. We must admire the courage of these early inventors, to take the bold step of abolishing the hand stitch and substituting this system of "laying on" the thread, and call it sewing. Our ancestral mechanics must have found it almost impossible to get any results, even after they "got the hang" of them; but a beginning was made, and we can date the progress from that time.

The honor of securing one of the first patents on a sewing machine rests on a man to whom it is never given—our own George H. Corliss—he was three years ahead of Howe, with a combination of awls to put holes in the fabric for the needle to pass into. He was entirely on the wrong track, and his machine never amounted to anything except, perhaps, for others to improve upon. He was shrewd enough to see his failure and devoted himself to the steam engine—luckily for us.

In 1851 Mr. Singer began his career of patent procuring, adding and simplifying the then almost impossible machine, bringing it within the range of human skill to maintain in operative condition.

About this time a new machine appeared; it was the "single thread" of Wilcox & Gibbs, which was remarkably simple compared with the others of that period. But one thread was used, producing a "chain" stitch seam, Fig. 2, which chain is the same as the one made in crocheting. Just when the "chain" was first made is a matter of ancient history, but the idea of using it as a seam was good, and had several advantages. To produce this, a double-ended hook, Fig. 3, was (and is) used. The needle having an eye near its lower end, through which the thread passes, is given a reciprocating motion, entering the fabric on its downward stroke, carrying the thread with it to its lowest position. On ascending, the hook is timed to project its point into the loop thrown out from the needle (the thread being held stationary in the fabric), and, continuing its rotation, draws enough thread through the eye to form a large loop. The fabric now feeds, so at the next entrance of the needle it enters this loop, which is spread by the "tail" of the hook. Casting this off around the new loop completes a stitch.

It is evident that, by pulling the free end of the thread, the whole seam can be readily drawn out, which is a serious drawback, unless the position of the parts of the thread be changed, and the ends fastened, by making a sort of slip-knot. This fact was the great weapon used by the "lock" stitch concerns to belittle the single thread claims. The chain uses more thread in actual stitching, but in speed there is no comparison, a speed of 3,800 stitches per minute being already reached with this principle.

The shuttle, Fig. 4, which carries the locking thread of Fig. 1, is projected through a loop, similarly produced as the single

thread loop. Suspended in its interior is a bobbin carrying the thread, which is drawn half way into the fabric, at which time the shuttle returns to its original position. This movement could never approach the rotary hook in speed, or simplicity, still the seam was less liable to rip, even though it was less flexible, and, like the other, is adapted to its own class of work.

The two classes have been described, and these main points will be found in every sewing mechanism, the differences between the two being as distinct to-day as thirty years ago, when the battle was first begun. Now each machine has found its field of usefulness, which is broad enough to occupy its entire attention; in fact, some builders of the shuttle type are now making a line of single thread machines.

The Wilcox & Gibbs concern was the one which fathered the single thread idea, and which alone brought it to its present perfection. Their machine gives the under loop a twist before it is drawn up against the fabric, producing increased friction between the threads of the finished seam. Our friends, Messrs. Brown & Sharpe, are the builders of the W. & G. machines ("enough said," as to construction).

The parts have, as near as is practicable, rotary movements, except the needle, which is always reciprocating. To produce this, the same order of changes have to be passed through as in other machinery: at first simple, then novel, and, as a rule, complicated; now, simple, the crank and pitman being generally used. The main difficulty has been to get sufficient time or pause to allow the point of the hook into the loop; some cases show a cam driven needle bar; but the writer has seen a system of links which slightly lift the needle, allowing then a pause for the hook. This will be described later.

The hook of the chain stitch is generally rotary, but the shuttle has had all sorts of movements. The rotary hook has been altered in shape; the shuttle has been completely revolutionized, a few having attained a successful rotary one.

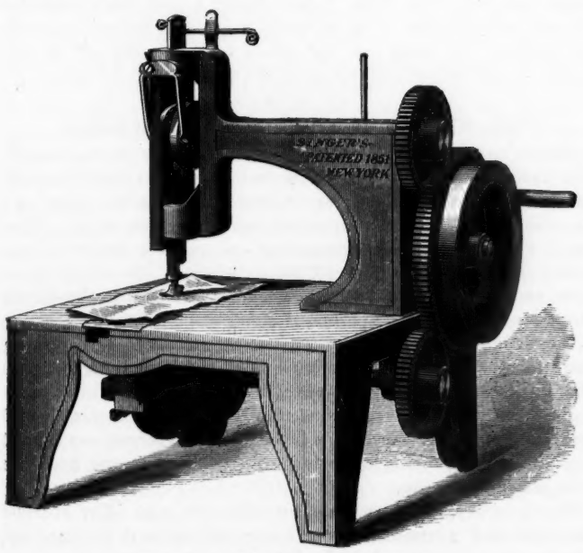


FIG. 6. SINGER'S FIRST MACHINE.

Another necessary part in every machine is a "take up" and tension. At the end of the stroke of the needle, a quantity of loose thread is hanging under the fabric, and the upper thread is laid loosely in its position. The take-up, Fig. 5, *B*, is a lever pivoted above the fabric, which pulls the thread quickly through the needle and eye *A*, until it is tight, the exact strain being regulated by the "tension" between the spool and *B*. The lever *B* is given more throw than is necessary to draw the seam tight, the extra motion drawing enough thread from the spool for the next stitch.

It is surprising to see what a light cotton thread will stand, at enormous speed: off the spool, through tension, take-up, needle, through the fabric, caught by hook or shuttle, carried around it, then cast off and drawn tight, it rushes in a perfect torrent. It breaks occasionally, but from other causes than mere strain—some materials will cut the strongest silk thread.

For feeding, a roll with ratchet and pawl are used in some cases, but nearly universal is the employment of the "presser-foot" and feeder. The feeder is a toothed plate with four movements, up (to a point a little above the machine bed, lifting the "presser-foot" which is held by spring pressure on the top of the fabric), then feeding; then dropping below the bed, to finally return at this level, to its initial position, the foot holding the fabric to the bed for the entrance of the needle. The four movements of this feed are not easy to obtain, often involving quite a few levers and

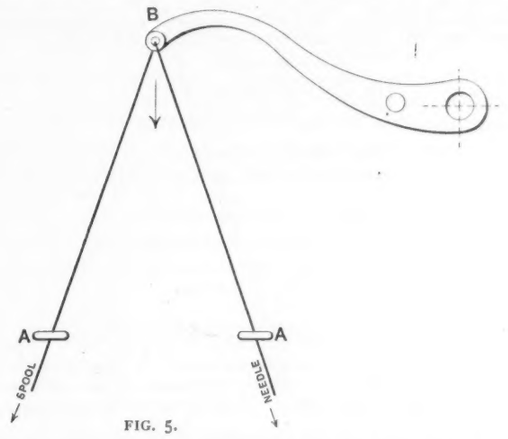


FIG. 5.

links, cam-driven, and in nearly every case giving only two of the four movements, the other two dependent on springs. None of them are as good as they might be, some being positively bad, and offer a good chance for invention and improvement.

These machines are for straight sewing on ordinary fabrics, and do not, in any way, show the possibilities of ornamentation of the advanced machines now in use.

* * *

ATTEND TO BUSINESS.

A certain manufacturer whose factory is in a small town, has been in the habit of getting his catalogues and other printing done out of town, for the very good business reason that he could get it at considerably lower prices, on account of being done in a town which is a "printing and publishing centre," whereas the principal facilities for printing in the manufacturing town are in the "job office" of the local paper.

The manager of the local paper has expostulated with the manufacturer for getting work done out of town, which "belongs in town," according to the argument of the newspaper manager; every new catalogue or other job of printing has been the occasion of the newspaper man stopping the manufacturer on the street and telling the manufacturer how unfair he was, and even made the matter the subject of a "leader" in his paper.

At last the manufacturer, to keep peace in the family, agreed that the job office should have an opportunity of estimating on the next catalogue, and when the copy was ready telephoned the newspaper man, who wanted to know if "to-morrow would do."

It was agreed to hold the copy till "to-morrow" and the newspaper man agreed to come "to-morrow" and look it over and make an estimate.

"To-morrow" came, but the newspaper man did not, and the day after "to-morrow," the manufacturer telephoned to the "job office" to see when the newspaper man was coming to look at the copy, and was informed that Mr. Newspaper man "had to go out of town and couldn't come," with no explanation as to when he could come.

* * * * * * * *

(These stars mean that the catalogue was printed out of town as usual.)

This is not a very exciting story, and might seem out of place in a mechanical paper, but there is a principle involved that applies to everybody and everything.

No printer or manufacturer "owns" his customers; if he don't attend to his customers there is always a competitor around the corner (or out of town) who will, and this is also true of the shop itself: a man may be a good machinist, but if he does not attend to his business there is always some one else who will, and who will in consequence have the preference; the mere fact of his being a good workman is not enough, and the man who expects the mere fact of his being a good workman, to make him successful, will be disappointed, as he is in the same position of perpetual motion machines, which usually have plenty of mere pressure, but do not seem to know that pressure must be multiplied by motion to generate power, and it might be a good thing for every machinist to write on a card,

"Power is pressure multiplied by motion."

and stick it up on the inside cover of his tool chest, where some other cards containing pictures or subjects not strictly mechanical are sometimes seen.

SLOW PAY.

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AMERICAN MACHINERY IS THE TITLE OF THE FOREIGN EDITION OF THIS JOURNAL, WHICH IS PRINTED ON THIN PAPER AND COMPRISES ALL THE READING MATTER AND ADVERTISING IN THE DOMESTIC EDITION. THESE TWO EDITIONS INCLUDE THE LARGEST CIRCULATION OF ANY PUBLICATION IN THE MACHINERY TRADE.

MARCH, 1898.

Three classes of small, duplicate-part machine work have been developed in this country to a remarkable extent. They are firearms, sewing machines and bicycles. In some respects the work upon all of them is similar. Many of the same regular and special machines are used upon all three. In other respects the work is quite different, but it is all interesting to any one who likes accurate and well-organized machine work. In this and in future numbers we shall devote space to some of the interesting features of sewing-machine manufacture, written by our contributor, F. W. Brady. Strangely enough, this important branch has heretofore been overlooked by the mechanical press.

* * *

Referring to a brief note in a recent issue of MACHINERY in which the coal consumption at the Warren Mills, of Providence, R. I., is given, on the authority of Dr. R. H. Thurston, as 1.35 pounds per horse-power hour, Heine boilers being in use, H. Armstrong, engineer at the works of the Middletown Plate Co., Middletown, Conn., writes us: "At the Grosvenor-Dale Co.'s, North Grosvenor-Dale, Conn., with plain, horizontal tubular boilers and a Wheelock engine with the Hill valve gear, the test showed a coal consumption of 1.32 pounds of coal per horse-power per hour."

We are obliged to Mr. Armstrong for calling our attention to this test. Both this and the test at Providence show about the best results that can be expected in the present practice in steam engineering. Not the least remarkable feature of these tests is the slight variation in the efficiency of the two plants, considering that different types of boilers were in use, the Heine boiler being, as is well known, of the water-tube type, and while the engines were both of the two-cylinder compound type, they differed widely in the relative ratio of high to low pressure cylinders, in one instance their ratio being 4.5 to 1 and in the other 7 to 1.

* * *

By way of comparison with the above figures, it is interesting to note the best performances of the gas engine as recently given by Dugald Clerk, the English authority, in "The Engineering Magazine." He says, "A large gas engine such as that built by the Messrs. Crossley, called 80 h. p. (nominal), will run at full power on a consumption which may practically be taken as one pound of anthracite fuel per indicated horse-power hour." This, while better than the best steam engine performance, is far better than it would be possible to secure with a steam engine of only 80 horse-power. Mr. Clerk points out the difficulties in the way of larger gas engines, but predicts that 1,000 horse-power engines will be common within ten years. For an engine of this size he estimates a consumption of only 12 cubic feet of gas per brake horse-power per hour, judging by the present best practice of 14 1-3 cubic feet. It will be interesting to learn whether the large gas engines now being built in this country will reach the figure of 12 cubic feet.

* * *

About the only criticism we hear in regard to the reading matter in MACHINERY is directed against the articles containing formulas; yet it would not be possible to cover the field we represent without the occasional use of such matter.

MACHINERY is first of all a shop paper—we may truthfully say *the* shop paper—and before anyone else we think of the man in the shop. What interests him, what helps him, what we can do to make his two dollars a day into three dollars, and in course of time into more money yet, is our earnest thought and constant endeavor; but the man in the shop who reads MACHINERY will not stay very long at his two dollar a day job, nor is he always going to be satisfied with rudimentary matter. His mind and pocket-book are both improving, and his reading must keep pace with them. There comes a time when formulas are necessary to him or his progress stops, and we must provide the reading he wants so that when he nears the top of the ladder he will still cling to MACHINERY as to an old friend.

* * *

THE EMERY-WHEEL AND GRINDING.

One of the radical changes that has taken place in shop methods during the past few years is that which has been brought about by the emery-wheel. It is comparatively a few years ago that the grindstone was in universal use in machine shops. Then came a long discussion concerning the relative merits of the emery-wheel and grindstone for tool grinding. The emery-wheel won, and now many pattern makers, even, prefer it to the grindstone for their fine-edged tools.

Meanwhile another debate was going on as to the wearing qualities of journals and bearings finished by grinding. Again the emery-wheel came out ahead, and while there still may be some hesitancy about grinding the more delicate, high-speed wearing parts, it is generally admitted that a ground and lapped bearing (lapping being but a form of grinding), is the best that it is possible to make.

For accuracy, grinding has easily taken the lead. The greatest precision that is attained in machine construction is by grinding, handwork excepted; and this precision can be attained, too, much easier than by any other method, and with less skill.

For speed, also, grinding processes are being used in many instances to better advantage than other ways of removing stock. A striking illustration of this is given by Professor Benjamin in his shop notes in this number, where a machine is described which is used for grinding the faces of pulleys. Finishing by buffing, polishing and grinding is taking the place of expensive bench work, and mechanics in charge of shops now prefer to "rough out" the pins, spindles and other cylindrical parts in a lathe and finish by grinding, not only because they get a better job by so doing, but because they get it done quicker and cheaper.

The reasons for such satisfactory results through grinding with emery or similar material, are almost self evident. Each little particle of emery is a tiny tool, very free cutting and so hard as to be almost indestructible. Hundreds, and perhaps thousands of these come in contact with the work at every revolution of the wheel, and it remains but to have the wheel true and to move the work in right relation to it to produce a smooth and uniform surface. The advantage of a ground surface is its close-grained

quality and the slight depth of the scratches or tool marks, as they really are.

This can be best appreciated by observing the result in forcing two pieces together. A 2-inch steel pin, for example, will drive hard in a smooth, reamed hole in cast iron, if it is finished by grinding and is .0005 of an inch larger than the hole. Moreover, if it is driven out and forced in the hole again it will require practically the same pressure as before, showing the superior quality of the surfaces for wear, finish or any other purpose. On the other hand, a pin of the same size filed up in the lathe will require from .002 to .003 of an inch for forcing to give like results, and when driven in the second time will go much easier than it did at first. Such a pin is neither round nor has it a good surface.

Grinding, for finish, accuracy, speed or wear will surpass, within its proper limits, any of the other operations of the machine shop. It is the only means of finishing hardened surfaces which are considered essential in the better class of machinery.

* * *

It is a little singular that so many people persist in chasing after the visionary advantage that is to be obtained through increasing the heating surface of boilers beyond that commonly given to a well proportioned boiler. "The Mechanical Engineer" illustrates a new kind of irregularly shaped tube for the purpose, which under test showed a superiority of "almost two to one of the plain tube." The tube is of such a shape, however, that it will be impossible to clean it thoroughly, and the two-to-one efficiency would soon be the other way around in favor of the old-fashioned cylindrical tube, because of the accumulation of soot. The inventors of good flue-scrapers have done more for the efficiency of steam boilers than all the inventors of increased-heating-surface schemes ever devised.

* * *

ECONOMY OF THE CORLISS ENGINE.

What are the reasons for the economy of the Corliss engine? This is practically the question that a subscriber asks in the How and Why column in this issue. Many people seem to attribute the economy to the trip cut-off, or virtually to the fact that the cut-off is sharp and varies with the load, while the other events in the stroke—admission, release and compression remain fixed, thus producing nearly an ideal indicator card. These features doubtless help, but they are not by any means the chief causes of the economy of the Corliss engine.

It will be remembered that a certain firm of engine builders put an automatic, single-valve engine on the market, a few years ago, in which the valve was so controlled as to produce an indicator card resembling a Corliss diagram, and claims of economy were made on this ground, which, however, we presume were never realized, because the other conditions for economy were not met.

The Corliss engine has generally been made in medium and large sizes. This in itself is conducive to economy, as it reduces the evil results of cylinder condensation, and it is an excellent feature to start out with. Then this engine is usually constructed with a long stroke, giving a fairly high piston speed, which is another desirable point. Other things being equal, however, the two most important sources of economy appear to be, first, the separate inlet and exhaust valves, which make it unnecessary for the live steam to pass through the passages and over the valves that have been cooled by contact with the exhaust steam and left in the best possible condition for absorbing heat; and second, the location of these valves near the cylinder ends, reducing the size of the passages and making the clearance spaces comparatively small.

A throttling engine having these features would be an economical machine. But couple with them the superior arrangement of the automatic principle as found in the Corliss engine, and all the conditions necessary for economy are very well fulfilled.

* * *

We have received requests from readers that articles be published upon turbine water wheels, brass founding, acetyline gas, propeller construction, the link motion, and various other subjects. We are grateful to all subscribers who thus show so kindly an interest in MACHINERY, and should be glad to comply with all requests for articles of general interest, but manifestly this would be impossible through lack of space. Many contributions that have been published have been in direct response to suggestions received, as are others we are arranging for.

WORK IN SCHOOL LABORATORIES.

There is now being constructed for use at the Massachusetts Institute of Technology, a powerful testing machine (500,000 pounds capacity), for testing the strength of full-sized building arches of brick, stone or other material. The machine will be large enough to take in arches up to 16 feet span, and it is expected that it will be powerful enough to crush any arch of ordinary proportions up to this size. The results obtained from these tests will be of considerable value, as the machine will measure the thrust exerted by the ends of the arch as well as the force required to crush it. While it is known that a well-constructed arch will sustain all the load that is likely to be put upon it, the question of end thrust is one of the greatest importance, and one concerning which there is no reliable information; and the way in which to meet this thrust is a serious problem in many structures. In this testing machine the end thrust is to be measured by the stretch of tie-rods connecting the two ends of the arch, these rods having previously been calibrated.

We call attention to this machine because it shows how great are the extent and variety of the work done in the testing laboratories of the larger technical institutions, and because it is the latest and one of the most striking examples of the modern tendency to test full-sized specimens of the kind that are to be actually used and as nearly as possible under the conditions that are met with in practice.

Twenty-five years ago there was scarcely a school in the country which pretended to give any attention to the class of work now done in the testing laboratory. At the present time, however, the school without a laboratory, more or less complete, would be even more difficult to find than would have been one with a laboratory in the early days.

The establishment of these laboratories was a step in the right direction. Before then instruction had been confined to text-books and the class-room. Aside from drawing-room work, it was entirely theoretical and kept the student at arm's length from the applications of his work that he would meet with in later years.

Many practical men, however, who are watching the trend of technical education, believe that there is such a thing as carrying the work in the laboratory too far for the best interests of the student who desires to obtain the most of value that he can during his course of study. We have never heard a limited amount of this work objected to. Every graduate, for example, ought to know about engine testing and the transverse strength of beams from actual experience. But why should it be necessary for every student to go through with a long series of tests of every conceivable kind of apparatus or material, when in 99 cases out of 100 his future work will be along entirely different lines?

In most courses there are certain options, students being allowed to devote part of their time to subjects of their own choosing. An option in laboratory work would certainly meet the wants of those who wished to specialize in that line, and would give others who desired to enter more deeply in other lines the opportunity for doing so. If every student were given a little less regular time in the laboratory and those who wanted more could have it, there would be no room for adverse criticism.

With regard to the second point mentioned—that of testing full-sized specimens—the importance of using the results of such tests and of drawing conclusions from them, and them only, is not always realized. To illustrate, take the strength of timber as given in Rankine's Mechanics. Choosing a particular case, we find 11,000 pounds per square inch as the modulus of rupture of spruce beams. The tests showing this result were made upon small specimens, and, of course, the natural way was to select sticks that were straight grained and free from knots. It has been proved, however, that full-sized spruce beams, taken as they come, cannot be depended upon for a modulus of much over 3,000 pounds—about one-quarter the amount. Many other tests upon other materials show that variations in shape have given equally striking results, and this is also true of various forms of apparatus as well.

In machine design the question of strength and flexure does not enter to a great extent; but there are plenty of other chances for a mechanical man to make use of the results of engineering research. A safe rule to follow is to use only such data as were obtained under the conditions that are to be dealt with. The ability to select such data makes the difference between showing good judgment in one's conclusions, and guessing at them.

TRANSMISSION DYNAMOMETERS.—1.

DESCRIPTION OF VARIOUS TYPES.—THE USES TO WHICH THEY ARE PUT. A SIMPLE EXPLANATION OF THE CALCULATIONS INVOLVED.

SAMUEL WEBBER.

The dynamo-meter, or power measure, has made its appearance in various forms during the last century and a half, and I will not attempt to state from memory who were the earliest experimentors in pursuit of this problem, "to weigh a moving force." It may have been Hero or Archimedes. Perhaps for our purpose it will be safe to start with James Watt and the steam engine indicator. Valuable, indeed almost indispensable, as this instrument is, to determine not only the actual duty, but the proper adjustment and working of a steam engine, it is yet very much misunderstood, for it is often relied upon as giving the power

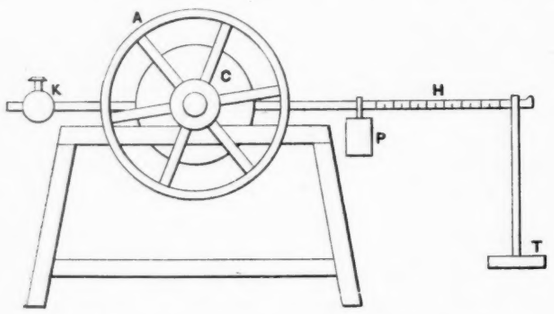


FIG. 1. BALANCE DYNAMOMETER.—ELEVATION.

delivered by the engine, instead of that which is consumed by it, which is really what is recorded, and from which must be deducted the power necessary to run the engine itself, which may be 6 per cent. and may be 20 per cent. of the recorded load.

Thanks to the investigations of Prof. Thurston, it has been pretty clearly shown that engine friction is a constant; so that if everything is disconnected from the engine, and a card taken running free, by deducting the area of this card from that of the one taken with the full load on, a very close result can be obtained of the power delivered.

Still, it is sometimes difficult, in case of a high-speed engine, to work out accurately the cards obtained when running without a load, and as in case of a water power an indicator card is impossible, there have been many attempts to produce a machine which should weigh the actual power consumed by any machine while it is being delivered from the prime motor, whether engine or turbine, and such instruments are therefore called "transmission dynamometers."

Most of the earliest ones of this class—like the indicator—depended on the compression of springs, and were actuated by a cam movement, from the first or driving pulley, and in most cases were fitted to record this movement, which was usually shown by a wavy line, due to the vibration of the spring, from which a true medial line of force was obtained.

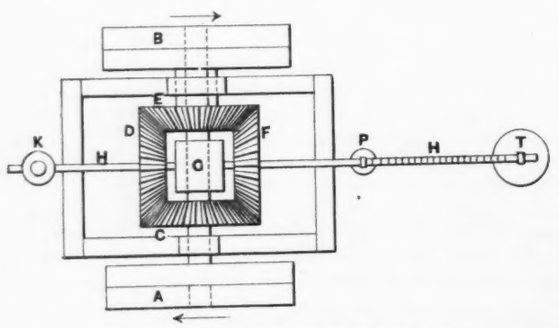


FIG. 2. BALANCE DYNAMOMETER.—PLAN.

Other inventors, however, sought long ago to obtain a regular weighing machine, on the principle of the old Roman steelyard, and the first one which the writer remembers was the "balance dynamometer" introducted by the late Samuel Batchelder, then of Saco, Me., somewhere previous to 1840, and then supposed to have been of his own invention.

Of late years, Mr. Wm. F. Durfee, in his researches, has discovered the original of this machine, in "White's Century of Inventions," a book published early in the present century, and it is very probable that Mr. Batchelder derived his idea from this book. This instrument Mr. Batchelder called "the balance dynamometer," and I reproduce it from memory in cuts 1 and 2, elevation and plan. On a strong wooden frame were a pair of boxes or bearings, supporting a shaft which ran across the frame. Outside the frame on one side was the receiving pulley *A*, on the other side the delivering pulley *B*. Inside the frame was a "box-gear," of four equal mitre gears. The first one of these, *C*, as well as the receiving pulley *A*, were fast on the shaft. The opposite gear *E* and the delivering pulley were mounted on a sleeve, through which the shaft passed, and received their motion from the two intermediate bevel-gears *D* and *F*, which revolved around a steel-yard *H*, through the fulcrum of which, in the center of the square block *G*, the shaft passed.

This steel-yard was made the radius of a 10-foot circle, or was 19.0985 inches, as nearly as possible, from the center of the block *G* to the extremity *I*, where the scale pan or weight-carrier was attached. In round numbers, it was just perceptibly short of 19 1-10 inches. It will be seen that if power was applied to the receiving pulley *A*, it would tend to lift the steel-yard, through the gears *C* and *F*, and communicate motion in the opposite direction, through the gear *E*, to the delivering pulley *B*, and by hanging weights on the scale pan *I* until the steel-yard remained level, and counting the number of times per minute in which it would revolve in a 10-foot circle, if it were free to move, the exact number of foot-pounds per second or per minute could be ascertained with absolute correctness. It was necessary, however, to prepare for more minute divisions of the weight than could be obtained by the change of a pound, or even a quarter pound, at the end of the steel-yard; and the sliding poise *P* accomplishes this, in this way:

Starting from a point just outside the frame—say, 8 or 8½ inches from the center or fulcrum of the steel-yard—a space of 10 inches was laid off and graduated into tenths of an inch, mak-

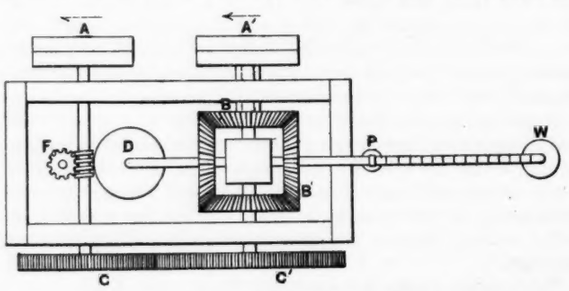


FIG. 3. AS IMPROVED BY J. B. FRANCIS.

ing 100 divisions, and a poise weight prepared by calculation; so that every notch it was moved out represented 10 pounds in 100 revolutions, every inch 100 pounds, and the full 10 inches of the scale 1,000 pounds, the same register as that of a 1-pound weight at the end of the steel-yard making 100 revolutions of the 10-foot circle.

This poise had, however, to be calculated to register 100 pounds for each 100 revolutions of a circle of 1-inch radius, or 6.2832 inches, while the main steel-yard marked revolutions by feet.

Dividing 12 inches by 6.2832 inches, it will be seen that it requires 1.92 pounds moved around the smaller circle to equal 1 pound moved around the larger one, and the poise was so calculated.

Now it will be seen, also, that while the same number of revolutions will be given to the delivering gear and pulley as are applied to the receiving one, the steel-yard around which the intermediate gears revolve would only make half as many, or 500 revolutions per minute, while the main shaft was making 1,000; so that in actual use the weights are doubled, and the poise is made 3.04 pounds, while the weights in the scale pan are 2 pounds instead of 1; and as the speed is counted by 100 revolutions, or 1,000 feet, each 2- pound weight is marked 1,000 pounds, and each inch on the steel-yard 100 pounds.

This early machine, as I remember it was rather crude, with ordinary cast gears, and with a sliding counterpoise *K* on the

opposite end of the steel-yard, by which it was balanced, when running at the proper speed, before commencing weighings. It had also some decided inconveniences, as the delivering pull ran in the opposite direction to the receiving one, thus necessitating the use of a cross belt for either receiving or delivering the power; while the pulleys not being in the same vertical plane, either the machine to be weighed had to be moved on the floor, or the driving pulley overhead moved on its shaft the width of the dynamometer.

The late Jas. B. Francis, of Lowell, then took hold of the instrument, and added a second shaft, bringing both sets of pulleys in line on one side of the frame, and connecting the two shafts by spur gears on the other, as shown in cut No. 3.

By the advice of the late Uriah A. Boyden, he added the "dash-pot," or hydraulic regulator, to the end of the steel-yard opposite the weight. This consisted of a piston playing in a cylinder filled with oil or water, with sufficient freedom to permit of a slow motion, the liquid passing up or down around the piston, but so tight as to prevent any sudden motion; thus obviating any chatter

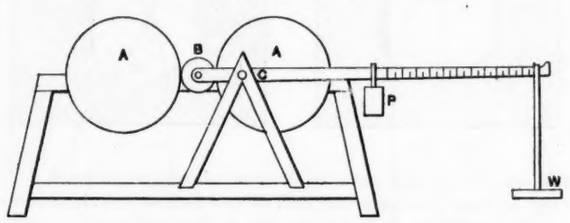


FIG. 4. INSTRUMENT MADE BY SAMUEL BROWN.

or tremble due to the driving belt slipping or creeping. For a 3-inch cylinder the piston is from 2⅞ to 2 15-16 inches diameter. Mr. Francis also put a worm on this second shaft, with a gear of 100 teeth, which rang a bell, thus enabling the 100 revolutions to be timed readily from an ordinary watch. In cut No. 3, *A A'* are the pullies, *B B'* the bevel gears, *C C'* the spur gears, *D* the dash-pot, *W* the weights, and *P* the sliding poise.

It will be seen that the pulleys are now in the same plane, and move in the same direction, and it is a simple matter to belt from the shaft on to the receiving one, and from the delivering one to the machine to be weighed.

No. 4 is an outline sketch of another "lever dynamometer," which the writer remembers, in the early forties, as built by Mr. Samuel Brown, then master mechanic of the Booth Cotton Mills, at Lowell. It has since been built by Fales & Jenks, of Pawtucket, R. I., and is also sometimes known as the "Kilburn dynamometer." This had two shafts, with pulleys on one end, and spur gears, *A A'*, on the other; but the gears were not in contact, and the power was transmitted from one to the other through a pinion *B* hung on one end of the steel-yard and supported from a fulcrum *C*. This also proved an accurate instrument, though not quite so convenient as the form previously described.

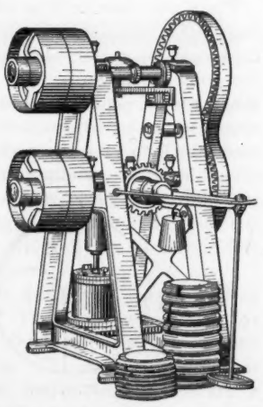


FIG. 5. WEBBER DYNAMOMETER.

In 1883 or 1884, after making many hundreds of weighings with a "Francis" dynamometer built the Amoskeag Company, at Manchester, N. H., under the directions of the late Gov. E. A. Straw, the writer decided to remodel the instrument entirely and put it in a more compact and portable form, and accordingly made the drawings from which the machine shown in cut No. 5 was built by Messrs. S. S. & W. O. Webber, at the Lawrence Machine Shop, and which has since gone by his name.

This machine measured 28 x 24 inches on the floor, weighed 280 pounds, and could be placed in any cotton mill alley without disturbing the regular machinery.

The driving belt is brought down from the shaft overhead to the upper pulleys, and a belt taken from the lower ones to the machine to be weighed.

The gear teeth and weights were calculated to carry 1 horse-power per 100 revolutions of the dynamometer, and it was not expected to use it at over 1,000 revolutions per minute, or 10 horse-power. Circumstances have, however, compelled the writer to run it at as high a speed as 1,500 revolutions per minute, getting 15 horse-power; but as that gave the teeth of the spur gears a velocity of 4,500 feet per minute, he did it with some hesitation. The result, however, was entirely satisfactory, and no trouble was found in the gears. Since then his son, Mr. S. S. Webber, of the Trenton Iron Company, has built one capable of transmitting 20 horse-power, if speeded high enough.

The machine was perfectly balanced as built—the steel-yard on its shaft, with the weight pan on the end; the poise weight standing at *O;* and the piston at the other end, in the dash-pot, in oil, was laid on a pair of straightedges, and permanent weight added to the piston of the dash-pot to accurately balance the longer arm of the steel-yard. This balance weight can be seen in the cut, above the dash-pot. The whole machine was then put together, and has been in use by the writer and his sons, at intervals, ever since.

The construction of the dynamometer has, for the present, been sufficiently described, and it now remains to explain its practical use. With small powers and high velocities, the commonly accepted unit of the horse-power—i. e., 33,000 pounds lifted 1 foot per minute—is divided by 60, and 550 pounds 1 foot per second becomes the basis. We therefore go to work in this way: Setting the dynamometer in proper position, we attach the belts, as noted, from the shaft and to the machine, and put on the power. The weights are hung on the steel-yard until it exactly balances on a level, and the time consumed in making 100 revolutions is read from a watch, by the stroke of the bell. It is not safe to depend on merely 100 revolutions; so the writer counts 1,000, at all high speeds, and divides it by 10. Thus, 83 seconds per 1,000 revolutions per minute gives 8.3 seconds per 100.

As the weight on the steel-yard is supposed to travel 1,000 feet in 100 revolutions, and for convenience are marked in thousands, the weight representing 1 pound being marked 1,000, and so on; when the steel-yard is balanced, these weights are added up, plus the amount shown by the poise, the speed counted, and the belt from the dynamometer to the machine thrown off, and the dynamometer again balanced without any load.

This last weight is subtracted from the first one, and the remainder divided by the number of seconds occupied in making the 100 revolutions.

This gives the foot-pounds, which divided in turn by 550 gives the horse-power.

The following example, taken at random from one of my old note-books, will show the *modus operandi* clearly:

Slater Mills, Pawtucket, Nov. 20, 1890.

One Potter & Atherton 40-inch cotton lapper, 14-ounce lap; doubling 4 to 1 = 2,166 pounds per day; beaters making 1,415 revolutions per minute; dynamometer making 1,000 revolutions in 62 seconds.

Total weight on steel-yard.....	20,000	pounds
Less balance running free.....	200	"
Net weight.....	19,800	"

19,800 ÷ 6.2 = 3,193.5 foot-pounds.
3,193.5 ÷ 550 = 5.805 horse-power.

* * *

Do not forget that in order to keep the "What Mechanics Think" column up to its present standard, every subscriber who takes an interest in it must feel a personal responsibility in sending contributions. These contributions we aim to pay for according to their value so that every one may feel suitably repayed for his trouble. The accumulation of ideas from various mechanics in different parts of the country and the publication of them from month to month cannot fail to materially assist as well as interest every machinist. Every mechanic has a certain number of original ideas that have helped him and that will help others. We want to have them for this department.

* * *

Manufacturers, either domestic or foreign, who intend building new plants or adding to their present ones, who are looking for special tools, or who want to buy or exchange machinery, are offered without charge the use of the information on these subjects accumulated in this office. Such inquiries are not published without the special request of those who send them.

SHOP TALKS WITH YOUNG MECHANICS.—3.

THE SUBJECT OF DRILLS—THE DIFFERENT FORMS AND SIZES—HINTS ABOUT GRINDING —USEFUL TABLES.

W. H. Van Dervoort.

The twist drill which has come into such universal use, has superseded the old, flat, forged drill which, for so many years, held without rival the first position as a tool for producing circular holes in metal. For the needs of its day, it served its purpose well. The advancements along mechanical lines demanded a better tool for this work, however, and the twist drill resulted, brought out in practically the same form as now used, the principal recent improvements being mostly in slight changes in form, and its more accurate production due to improved methods of manufacture.

The flat drill, as used for metal work, is generally of the form shown in Fig. 28. It is made from round stock, is forged thin at the lips, and ground as shown in the figure, with three cutting edges—*A*, *B* and *C*. This is a very accommodating sort of a tool, being capable of producing a number of holes of different diam-

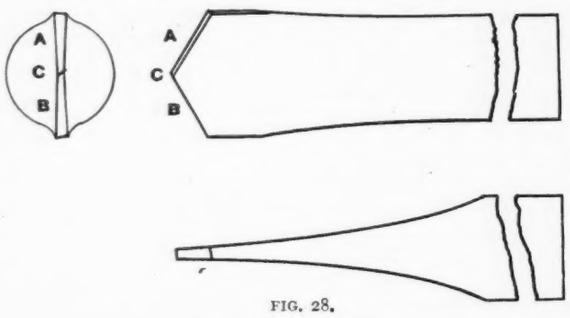


FIG. 28.

eters, yet, approximately, the width of the drill. The disadvantage of this adjustability, however, lies in the fact that the size of hole wanted cannot ordinarily be produced.

The flat drill has no lands, as that part of the twist drill between flutes is called, to steady and guide it in the work. Consequently, the hole drilled will usually not be round, and should the point of the drill strike the side of a small blow hole or soft spot in the metal being drilled—as frequently happens in working cast metal —the point will drift towards this spot, thus making a hole that is neither round nor straight. This is shown in Fig. 29.

In order to drill holes approximately to size with the flat drill, it is necessary that the cutting lips be most carefully ground. The angle of the lips with the axis of the drill must be equal, otherwise one cutting edge will perform all the work, and will dull quickly, due to this double duty. The pressure on the cutting lip will crowd the point, causing it to revolve in a small circle about the center of revolution. This will cause the other flute to cut slightly at its outer end, thus producing a hole of larger diameter than the width of flat. This is shown in Fig. 30.

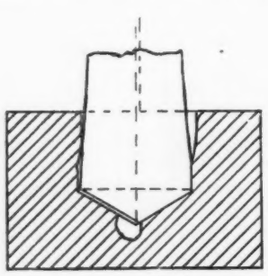


FIG. 29.

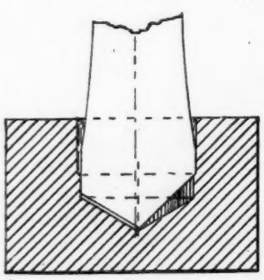


FIG. 30.

The cutting lips should be of equal length with their intersection in the axis of rotation of the drill. If one lip is longer than the other, the diameter of the hole drilled will depend on the length of this long lip, as it will rotate about *C*, its central axis, as shown in Fig. 31.

In case the intersection of the lips does not fall on the axis of the drill, the one lip is thereby made longer than the other, and the hole drilled will again be large, as the tool will spring an amount sufficient to allow it to revolve about *C* instead of its true axis, and the length of the long flute, again determines the diameter of the hole drilled, as shown in Fig. 32.

The first cost of the flat drill is small, and the results obtained by its use usually poor. Its only advantage lies in the fact that it can readily be forged and tempered to do work on extremely hard metals. The flat drill, ground thin and tempered hard, is a valuable tool for drilling hard steel or chilled iron, as it will in that form take hold of metal that the twist drill will not touch. It also makes a convenient extension drill, as it can be readily formed on the end of a long bar of steel.

The flat drill is not adapted to the drilling of deep holes, as it does not free itself of chips. It is largely used for roughing out cored holes, preparatory to boring, which work is very destruc-

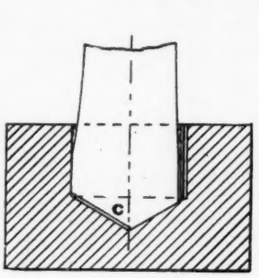


FIG. 31.

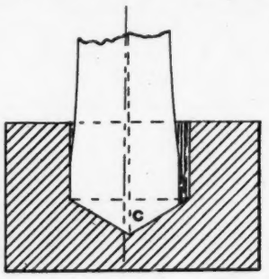


FIG. 32.

tive, due to scale and sand, to the land clearances of twist drills. When so used in a lathe, the drill is held against the dead center and fed forward by the tail screw, the work revolving.

About 1860, twist drills, having milled flutes, were first placed on the market. Previous to this date, however, drills with flutes produced by filing and the twisting of the flat stock had been used to a limited extent.

In Fig. 33 is shown a taper shank twist drill. *A A* are the flutes, *B B* the lands, *C*—the metal between the flutes—the web, *D D* the lips, *E* the shank and *F* the tang. The center or grinding line is the fine line running along the bottom of each flute, and serves as a guide to the lips in grinding so their intersection will fall in the center of the drill.

FIG. 33.

The three clearances in the twist drill are: first, the "body clearance" of one-half to one-thousandth of an inch per inch of length of the fluted portion; second, the "land clearance" of about one-half of one circular degree as shown at *A A* in the end view, Fig. 34; and last, the "lip clearance" made by grinding back the ends *G G* of the lands, Fig. 34, to properly clear the cutting edges *H H*.

There are three cutting edges, *H*, *H* and *C;* of these *C* is the least effective, as it is not a free cutting edge and grinds rather than cuts the metal. By reducing the thickness of the web at the point as shown in Fig. 35, thus making the cutting edge *C* short, the efficiency of the drill is materially improved. This is of greatest value with drills of large diameter where the webs are made thick to give the necessary strength. The points may be thus thinned by grinding on a small emery wheel.

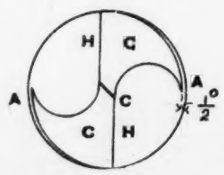


FIG. 34.

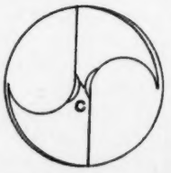


FIG. 35.

The flutes of twist drills as usually manufactured are cut by milling from stock of round cross section. Numerous attempts have been made to produce a satisfactory hot rolled drill, in which the flutes are formed by passing the stock which is rectangular in cross section and heated to a forging point, through spiral rolls. A hot forged drill has recently been placed on the market. In this tool the flutes and twist are produced by forging, and great strength and durability of cutting edges are the claims for it by the manufacturers.

In order to give the drill greater strength toward the shank, the web is increased in thickness from the point to the end of the flute. This thickening of the web is accomplished by gradually withdrawing the milling cutter from the blank as the cut advances. This makes the flute shallower at its upper end, with a gradually decreasing area of cross section from the point to the shank. This contraction of the flute area prevents the free delivery of the chips and consequent clogging of the drill. It is therefore necessary to make the flute area equal throughout its entire length. This is usually accomplished by making the pitch of the flute spiral uniformly greater from point to shank, and is known as an "increase twist" drill. It is also produced by giving the flute a spiral of "constant angle," and increasing the width of flute toward the shank. This latter result is obtained

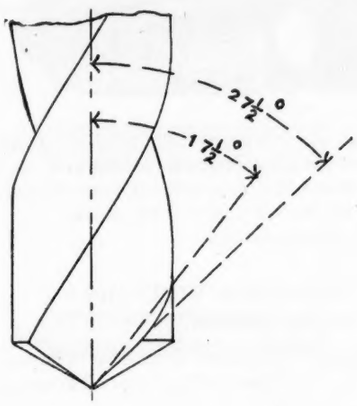


FIG. 36.

FIG. 39.

by slightly changing the angle of the arbor carrying the flute cutting mill with the axis of the drill blank as the cut advances, and the mill is receded from the blank, in giving a web of increased thickness. This latter method makes the lands narrower at the shank end of the flute and thereby reduces somewhat the strength of the drill. On the other hand, it possesses the advantage of giving a constant angle of rake to the cutting lips as the length of the drill decreases. This is shown in Fig. 36, where the angle of rake is 27½ degrees for either form of drill when the tool is new. When worn nearly to the shank, this angle in the "increased twist" drill is materially decreased, while for the "constant angle" drill, it remains the same.

For the small drills, the blanks are usually made from steel wire. They are first cut in lengths and then given a body clearance by filing. The flutes are each cut separately. With the drills of larger diameter, the blanks are turned in a lathe and finished to exact diameter by filing. In cutting, they are held upright in a vertical machine, both flutes being cut at the same time. The

FIG. 37.

clearance of the lands are made by either milling or grinding, and with the large drills both lands are relieved at the same time.

Drills are given a cutting temper the entire length of the flutes, and are carefully straightened after this process.

Twist drills are sometimes made slightly over size, and after tempering are ground perfectly straight. This adds little to the value over the properly straightened drill and increases considerably the cost.

Twist drills having more than two flutes are frequently used for enlarging drilled or cored holes. They are very efficient for this purpose, but as the lips do not intersect at the point, they cannot drill a hole from the solid stock. The straight flute drill is one having the flutes cut parallel to the axis of the drill, and are in other respects similar to the twist drill. A straight flute drill is shown in Fig. 37. In Fig. 42 is shown a hollow drill which may be used to advantage in the drilling of deep or long holes, the chips passing out through the hollow shank.

Great care must be exercised in grinding the twist drill, as the same troubles on a smaller scale as those shown in Figs. 29, 30, 31 and 32 for the flat drill will result from the improper grinding of the twist drill. The angle of lip clearance should be greater at the center than at the outer ends of the lips and must not be excessive, as in that case the drill bites too rank. If this angle is too small, however, the cut is not free and excessive heating results. The angle of the lip to the axis of the drill should be 60 degrees. This gives a straight cutting lip as shown in end view, Fig. 34. There are a number of drill grinders made that will grind drills satisfactorily. The experienced mechanic usually prefers to grind his drills by hand, depending upon his eye and judgment for the proper angles and clearance. It is in this way that all new drills are ground before leaving the factory.

The standard shanks for drills are straight and taper. The taper shank is shown in Fig. 33. It is made in six sizes, and known as the Morse taper, which is approximately ⅝ inch per foot. The exact taper for the several sizes is given in the following table; also the limiting sizes of drills on which each taper is generally used:

TABLE OF MORSE TAPERS.

No. of Taper.	Taper per foot.	Smallest Drill using each Taper.	Largest Drill using each Taper.
1	.605	1/4	1 9/16
2	.600	7/16	2 3/16
3	.605	5/8	3 7/16
4	.615	1 1/16	1 3/4
5	.625	2 3/16	2
6	.634	Special.	3
			Special.

In Fig. 38 is shown the shank of what is known as the grooved shank drill to be held in a special chuck. These grooves may also be applied to taper shanks. Drills are also made with square shanks to be held in rachets and bit braces, also with shanks of various special forms.

Taper shank drills are made and carried in stock by 1-64 inch sizes from ⅛ of an inch to 2½ inches, and by 1-16 inch sizes from

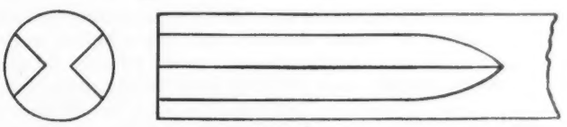


FIG. 38.

2½ inches to 3 inches. All sizes over 3 inches are special and made only to order. Straight shank drills are made by 1-64 inch sizes from 1-16 of an inch to 2½ inches. A regular straight shank drill is the same length over all as a taper shank. What are known, however, as jobbers' sets, running from 1-16 of an inch to ½ inch by 64ths, are considerably shorter than the regular lengths. The wire gauge sizes run from No. 80—the smallest twist drill regularly made—to No. 1. The No. 1 wire gauge drill is .228 or about 15-64 of an inch in diameter, while the No. 80 is but .0135, or a little more than 1-100 of an inch in diameter. This latter drill is an exceedingly delicate little tool, having flutes quite perfectly formed.

Drills are made in what are known as letter sizes, from A to Z, A being the smallest, .234 of an inch, and Z the largest, .413 of an inch. These drills are made with straight shanks. Millimeter sizes from 6 to 50 m.m. are made by most American makers.

TABLE OF DRILL SPEEDS.

Diameter of Drills.	Speed for Wrought Iron and Steel.	Speed for Cast Iron.	Speed for Brass.
1/16 inch.	1712	2383	3544
1/8 "	855	1191	1772
1/4 "	397	565	855
3/8 "	265	375	570
1/2 "	183	267	412
5/8 "	147	214	330
3/4 "	112	168	265
7/8 "	96	144	227
1 "	76	115	191
1 1/8 "	68	102	170
1 1/4 "	58	89	150
1 3/8 "	53	81	136
1 1/2 "	46	74	122
1 5/8 "	40	66	113
1 3/4 "	37	61	105
1 7/8 "	33	55	98
2 "	31	51	92

From 6 to 25 m.m. sizes increase by ½ m.m. advances. The millimeter drills are made in both straight and taper shank.

It has not been found practical to give drills smaller than No. 74 wire gauge, .0225 of an inch, land clearance, and many drills considerably larger than this are not so cleared.

Practice is somewhat at variance as to the best speeds at which to run drills. The later tendencies are to reduce the feeds and increase the number of revolutions, that is for the smaller sizes. For the larger sizes, the number of revolutions varies little from the old practice. The above table gives the speed of drills in revolutions per minute as recommended by the leading manufacturer of drills.

A rule that is easily remembered and gives approximately the correct speed is, dividing 80, 110 and 180 by the diameter of drill, will give the number of revolutions per minute for work on steel, cast iron and brass respectively. The results will be rather small for the smaller sizes and large for the larger sizes.

FIG. 40.

The feeds for drills should vary with the diameter of the drill and the hardness of the metal being drilled, and will usually be 1-200 to 1-50 of an inch per revolution of the drill.

In drilling wrought iron or steel, the drill should be flooded with oil, or some suitable drilling compound, which lubricates the cutting edge and carries away the heat of friction. Cast iron and brass are drilled dry.

A drill with cutting lips having no angle of rake will work best in brass. A straight flute drill or twist drill with lips ground as shown in Fig. 39 is well suited to this work.

In drilling deep holes in steel, especially when the drill is held in a horizontal position, it is difficult to properly lubricate the cutting edges of the drill. To overcome this, oil tube drills—one of which is shown in Fig. 40—are being very successfully used. In this tool oil is forced to the cutting lips, thus thoroughly lubricating them, at the same time helping to force out the chips and keep down the temperature. The usual method of making this drill is to mill small grooves in the lands parallel to the flutes and secure, by solder, in these grooves small tubes which, at the shank end, are usually made to open into a hollow in the shank from which suitable connection is made with the oil supply. One manufacturer uses the following unique method for producing these oil passages: Two small holes are drilled parallel to the axis in the stock from which the tool is to be made. The

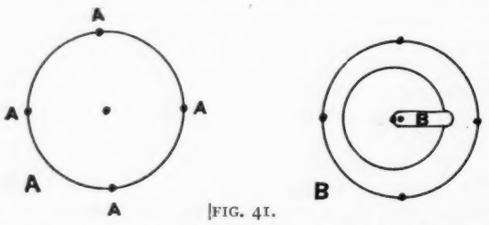


FIG. 41.

length of these holes is somewhat more than the length of the grooved portion of the finished tool, so as to connect with the hollow shank. After these holes are finished the stock is heated to a low forging temperature and then twisted an amount such as to make the holes come parallel with the flutes when cut. Oil tube drills are necessarily expensive to manufacture; their use will, however, frequently more than double the output of the machine driving them.

The drilling of holes that are to be tapped requires a drill equal in diameter to the root diameter of the tap, and is called a tap drill. The machinist soon fixes in his mind the proper tap drills for the taps he most uses. When there is any uncertainty as to the proper diameter, consult a table of tap drill sizes or caliper the end of the taper tap, and select a drill that will just allow the point of tap to enter; this will give a full thread. The following table gives the sizes of tap drills from ¼ of an inch to 1½ inches for the V. and U. S. S. threads. The U. S. S. number of threads per inch are those taken:

TAP DRILL TABLE.

Diameter of Tap.	No. of Threads.	Drill for U. S. S. Thread.	Drill for V Thread.
¼	20	3/16	11/64
5/16	18	¼	13/64
3/8	16	9/32	33/64
7/16	14	11/32	21/64
½	13	13/32	29/64
9/16	12	7/16	1/2
5/8	11	1/2	17/32
3/4	10	17/32	19/32
7/8	9	49/64	13/16
1	8	57/64	15/16
1⅛	7	1 1/64	1 3/64
1¼	7	1 9/64	1 19/64
1⅜	6	1 13/64	1 7/8
1½	6	1 29/64	2 1/64

The location of a hole to be drilled is usually indicated by a center punch mark; if the hole must be drilled exact to this center a circle of diameter equal to the diameter of the hole to be drilled should be described about the punch mark as a center, as shown at *A* in Fig. 41. A few light prick punch marks should be made, *A A A A*, on this circle. If the drill runs to one side as shown at *B* in Fig. 41, it can be drawn back by cutting away the wide edge with a cape chisel as shown at *B;* this chisel cut should run to the center. The drill must be brought concentric with the circle *A A A A* in this manner before it begins to cut the full diameter, as it cannot then be readily shifted.

When the point of the drill breaks through the work and the pressure is thereby greatly reduced, care must be exercised in the handling of the feeds to prevent the drill from worming or drawing through without cutting the full circle. In case this

FIG. 42.

occurs, one of three things will certainly result: break the work, the drill, or stall the machine. A straight flute drill or a twist drill with lips ground as shown in Fig. 39 will not worm through and are good tools to use for drilling thin or sheet metals.

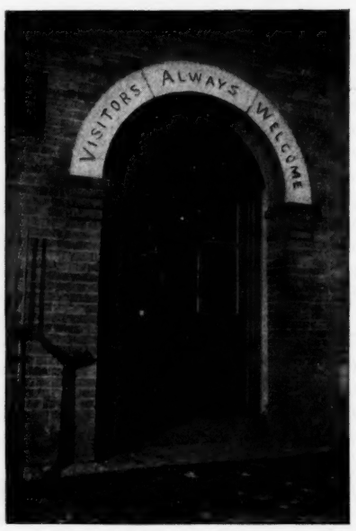
Keep the drill sharp by proper grinding.

* * *

SHALL WE WELCOME VISITORS?

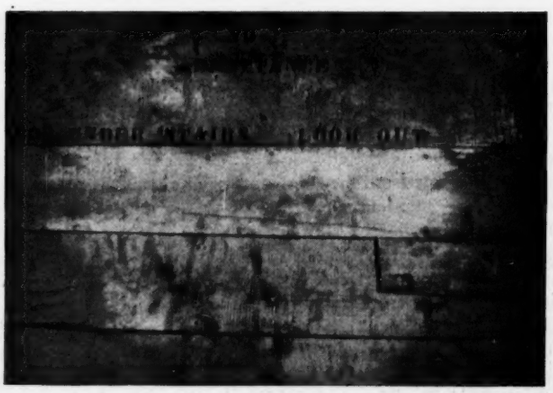
AN OBJECT LESSON.

Is it better to admit visitors to the shop, or to keep them out? Of course I do not mean by "admitting visitors" that all doors are to be left open and any one at liberty to come in and "own the place," but that mechanics (or others) who are interested should be shown around the works.



We show two cuts from photographs: one showing the entrance to the Straight Line Engine Works, of Syracuse, N. Y. The other is—but probably the less said the better.

Every reader of MACHINERY knows that the Straight Line Engine Works is run by Prof. John E. Sweet, and Professor Sweet says he thinks that admitting visitors is the best advertising that he does: take notice that the words "Visitors Welcome" over Professor Sweet's door are cut into the stone, and therefore cannot be chipped off (same as some people chip the maker's name from a machine).



Browne & Sharpe admit visitors to the works, and advertise the fact, and claim—so I understand—that they usually get as

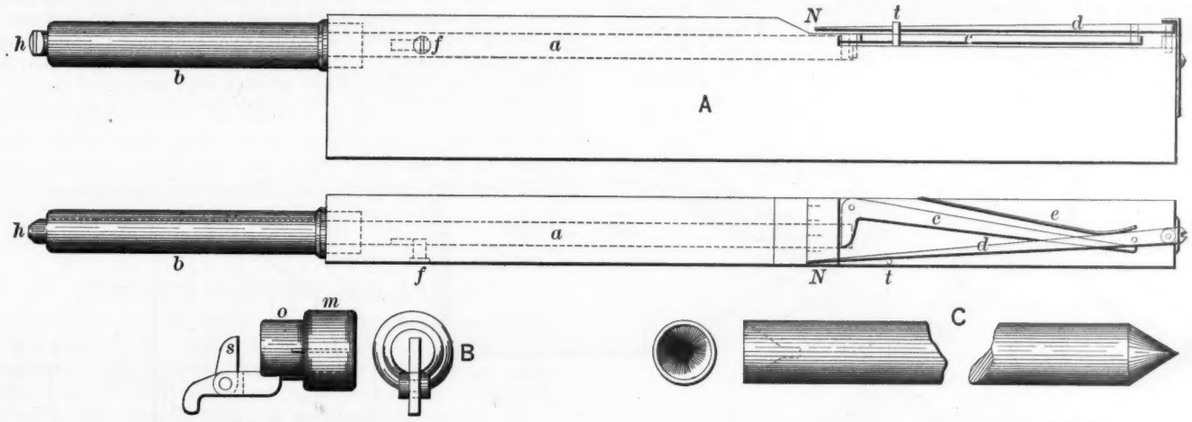
much information from a visitor as they impart to him during his visit.

"There are others," but these two examples are enough to illustrate the principle.

I have taken the ground that if a person wants very much to find out about a certain process in a certain shop, that he is going to find out anyhow, and that therefore there is nothing gained by keeping visitors out. Of course these remarks apply more particularly to machine shops.

I went to a certain place not long since with the idea of doing some business, and found the office door locked and a sign, "Ring the Bell"; I didn't ring it. Not long after I saw some machinery made by this concern, and was not surprised to see that it was exactly like machinery designed and made by others, with the probable exception that it was one shrinkage smaller.

Let the reader suppose that he wishes to buy an engine, or even to get a small job done; which of the two doors shown in the cuts would he prefer to enter? BEEN THERE.



FROM VARIOUS SHOPS.

A TEST INDICATOR.

The indicator illustrated in Figs. *A*, *B* and *C* was found among the tools of Mr. Frederick M. Bush, of Rochester, N. Y., who kindly furnished the sketches. It is not supposed to be new by any means, in fact, Mr. James Shaw, to whom Mr. Bush credits the idea, died some time ago.

The following description is submitted, although the sketches are so plain that remarks seem almost unnecessary:

The piece *a* is split on one end and the taper-threaded nut *m* enables it to be clamped on the end of *b*, with *s* in contact with *h* to provide a working point *r* at right angles to the spindle *a*, for truing up holes, etc. Perhaps it is all right as it is, but I would make *b* a little stiffer if I expected to use Fig. *B* on it.

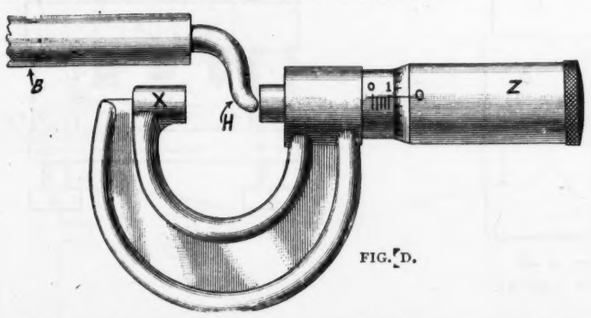


FIG. D.

When a prick punch mark is to be worked from, the pointed end shown in Fig. *C* is inserted in the mark with the cupped end on the tail stock center, then the indicator is held in the tool post at right angles to this piece with *h* resting against it close to the work. The compound multiplying levers *c* and *d* are each proportioned about 10 to 1, so a movement of Fig. *C* equal to .001 of an inch would read like .1 of an inch on the scale at *n*. *t* is a stop for the lever *d* when it is at zero, and the spring *e* resting against *d* takes care of all back lash when the tool is in use. Since the pointed bar of Fig. *C* is not expected to revolve with the prick punch mark, its accuracy is of little consequence so long as it has a good point, and if the cupped end is drilled out thin for perhaps an inch deep, then split in three parts, it will provide a slight "give" endwise. It seems as if this would tend to keep it from revolving on the center and take up the lost motion due to the wear of the prick punch mark, etc., and be desirable in careful hands, but Mr. Bush does not find that necessary, and possibly could explain practical objections to it. On the whole, this indicator seems to be a very neat and desirable little tool that overcomes the vibrations that are so annoying to the user of the long needle indicator, besides showing an error more plainly.

Having on several occasions seen apprentices trying to make some such rig, thinking that they must have the levers proportioned with mathematical precision in order to have it measure correctly, and begin by making the lines on the scale first, then be unable to think of any better way to test its accuracy than to turn a piece of metal with the different sizes on it to try the contrivance, prompts me to add the following:

A common method, where it is required to show the exact value of the error, is to scratch the lines on the scale after the parts are in position, and space the distance by aid of micrometer applied to *h*. When a micrometer without the loop cannot be had, a regular micrometer can be used, as shown in Fig. *D*, *h* being left long enough to bend over and make room for *x*. With the indicator and micrometer both fastened rigidly in relation to each other to a slab of metal or other article, locate the zero line on the scale, then turn the revolving sleeve *z* of the micrometer one or more thousandths as desired, which will move the pointer to the position where the second line should be drawn to indicate that amount, and proceed in the same manner to complete the graduations.

SETTING A MILLING CUTTER.

Usually, one of the jobs that stalls an apprentice the first time he gets it, is to set a milling cutter central with a round shaft to mill a key seat in it; and I have seen "all sorts" of methods tried with varying success.

One plan that I saw a bright young chap use serves a double purpose and gives results good enough for most purposes. He simply secured the shaft ready for milling and raised it until the cutter made a rounded hollow in the top side of it, then ran it back and forth under the cutter with the cross feed until it cleared the cutter in both directions. The movement sidewise was made to get the surface of the spot level in case the face of the cutter was not exactly straight and square. He proceeded in this manner until the widest part of the spot just equalled the width of the intended keyway, then set the cutter with one corner at each side of the spot which brought it central with the shaft. Before making any change that would affect the depth of the hollow, the index on the perpendicular feed was set at zero, which gave him a point to work from to index the depth of the key seat, and was better and quicker than measuring the depth from the corner of the slot where there is always a burr to contend with.

I have sometimes found it convenient to locate the center of a shaft when I wanted to drill a hole through it, by bringing the drill down until it would just touch the top of the shaft when it was passed under it sidewise. The shaft should be held so that it cannot revolve, and, of course, the drill touches at the highest point, which is directly over the center.

After the V-block or vise has been fastened in a position that will bring the center of the shaft under the axis of rotation of the drill, I think it is well in most cases to release the grip on the shaft until the drill gets most through—just enough so the drill can "wiggle" it—and raise the drill occasionally, as it is not so likely to work to one side. I am not speaking of work that must be done "absolutely perfect." A. L. G.

WHAT MECHANICS THINK.

A DEPARTMENT FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE.

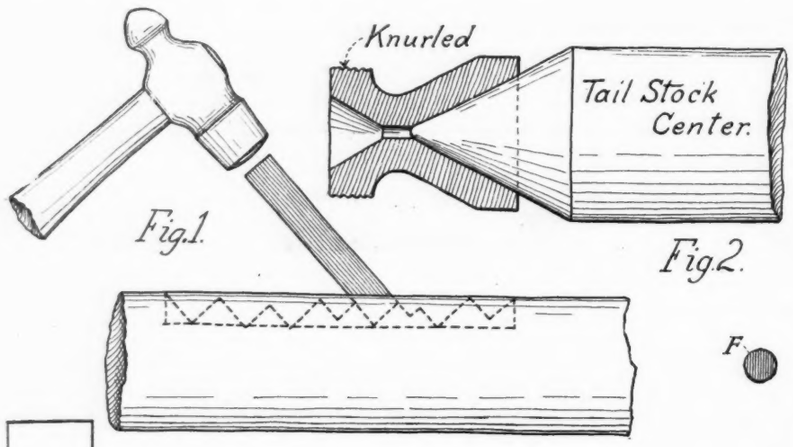
Write on one side of the paper only, and when sketches are necessary, send them. No matter how rough the sketches may be, we will see that they are properly reproduced.

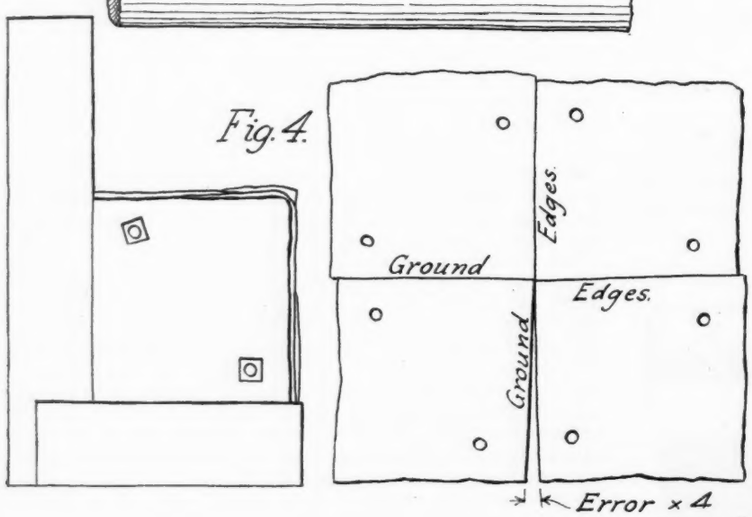
CHIPPING KEYWAYS.

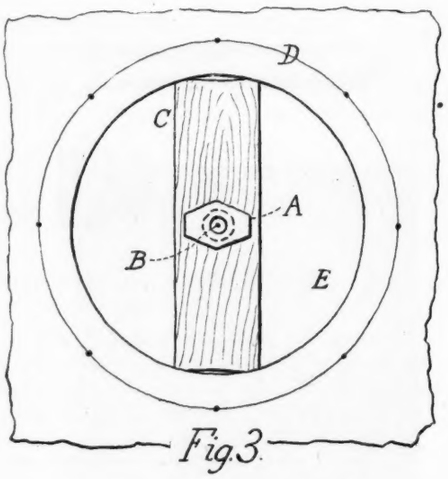
Here is a shop "kink" or trick, as it is called, which I consider to be of some value to machinists. It often happens that a person has a keyway to cut in a shaft which has a number of pulleys, etc., on it so that it cannot be placed in a machine for doing the job.

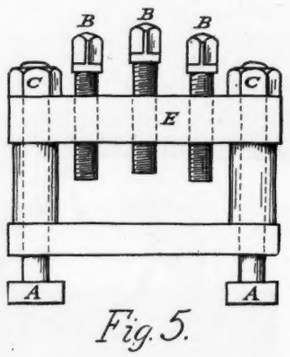
Now, it is very hard to chip a keyway straight and of the right width so as to fit the key nicely; but it is not very hard to chip it 1-64 of an inch narrow and keep within the lines. If this is done, the keyway can then be finished by filing one end of the key square and use it as a broach (Fig. 1). If necessary, the key can be hardened, and it will work best if it is broached a little at a time on a 45-degree angle, as shown in the sketch. This gives a nice fit for the key and is a quick as well as accurate method of finishing the keyway. J. E. HAYNES.

Franklin Falls, N. H.









A COLLECTION OF "KINKS."

UNIVERSAL FEMALE CENTER.

I enclose sketch of a female center which will commend itself to mechanics who have looked in vain for a twist-drill chuck that would fit their tailstock spindle. Its construction is apparent from the sketch (Fig. 2). It will fit any center having an angle 60 degrees, and a drop of oil placed on the center will exclude the air and cause it to remain in position. Of course it is necessary to have the two centers accurately in line, and to anyone possessing a thoroughly reliable self-centering chuck the problem of making the two centers in exact alignment would be simply a matter of starting with a cylindrical piece of the proper length, cutting out one end to the proper size and angle, then reversing it in the chuck and treating the other end likewise. In the absence of such facilities I would suggest excavating the large end, then, with soft solder, fasten it on a true live center and finish in that position.

Hartford, Conn. F. M. D.

LAYING OUT A CHUCKING LINE.

The finding of the center of a hole in a piece of work is not a very serious job, but to get it accurately so that a chucking line, *D*, can be drawn from it, requires time and patience. The ordinary practice is to cut a stick, *C*, long enough to fit closely in the hole, and on this to fasten a piece of tin, *A* (Fig. 3), by turning down the sharp points and pushing them into the wood. Then with the hermaphrodite calipers the center is found by trial. To scribe the chucking line a prick mark is required for the divider point and to locate it correctly is the trouble, as it is difficult to move it after being once pricked. To avoid this annoyance the tin can be made with a ¼-inch hole in the center, as shown at *B*, and having between it and the stick a small pellet of lead hammered down flat to about 1-32 inch thick. The center being found, it is readily pricked on the lead with the divider point, and if found to be not exactly right, the lead can be moved until correct; the friction between the tin and stick being enough to hold it unless moved unintentionally FRED E. ROGERS.

Corning, N. Y.

TESTING A SQUARE.

To test a square for accuracy take four pieces of sheet metal, clamp them together and grind the two edges to fit the square perfectly, Fig. 4. Now separate and lay the plates down with the ground edges together, as shown in the sketch, so as to complete a circle. Any error will then appear exaggerated four times. It will be seen that any of the larger angles that are a multiple of 360 degrees can be ground to extreme accuracy in this way.

Providence, R. I. JOWN W. BROADHEAD.

TWO OR THREE POINTS.

Sometimes, when drilling, countersinking or counterboring a piece of small diameter in the speed lathe, it is extremely difficult to keep the work from revolving; a metal clamp mars the work, and a wooden clamp won't hold. In a case like this I sometimes take a narrow strip of emery cloth, double it with emery side out, and glue it together. Then by wrapping it around the work a wooden clamp can be used to keep the work from turning.

In turning up to within a short distance of the end of a piece, it is sometimes necessary to run the cut towards the tail stock, and when running two lathes an automatic stop is useful to keep from running too far. In lathes which have a stop like that on the Fitchburg or the Brown & Sharpe lathe, if it will not work running backwards, take a piece of key stock of suitable dimensions and drill a small hole through one end. Fasten it by a wire through this hole to the movable trip, which may be set at any point, and place the piece between the catch and the latch. When it gets the length of the wire, it will drop out and allow the lathe to stop.

We have in use here what we call a double tool post of which a sketch is here shown in Fig. 5. The square boltheads *A* go in the tool post slot, and the rig is clamped by the nuts *C*. Through the top plate *E* pass three bolts *B* by which tools may be clamped. This simple affair saves its cost very quickly, as it can rough out a three stepped cone pulley, cut down on each side with two shovel noses, hold a shovel nose for cutting down and a side tool for squaring out, or do any one of a score of operations which usually have to be dogged and put in the lathe twice. R. E. F.

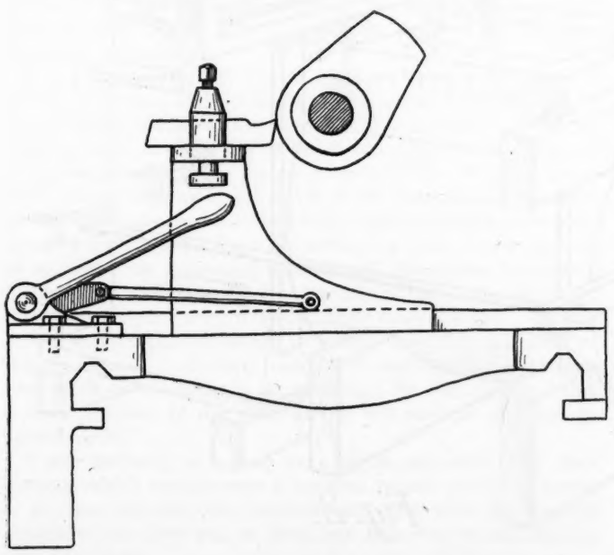
Pawtucket, R. I.

* * *

DEVICE FOR TURNING CAMS.

A device for cam turning is shown in the accompanying sketch. It is attached to an engine lathe and consists of a hand lever pinned to a rock shaft having a bearing bolted to the carriage; there is a rock arm or crank fast to the same shaft, which is connected to the tool slide by a link as shown. It will be seen that if the slide is disconnected from the cross-feed screw, a movement of the handle will cause a quick movement of the tool out or in.

The device can be used on cams of the shape shown, having two faces of different radii for the outer and inner limits of the throw. We take a cam and turn off the part for the outer limit of throw,



planing the flat parts in a shaper. In turning the part for the inner limit of the throw, the tool is pushed in while a cut is being taken over this part and then quickly withdrawn to clear the remainder of the cam.

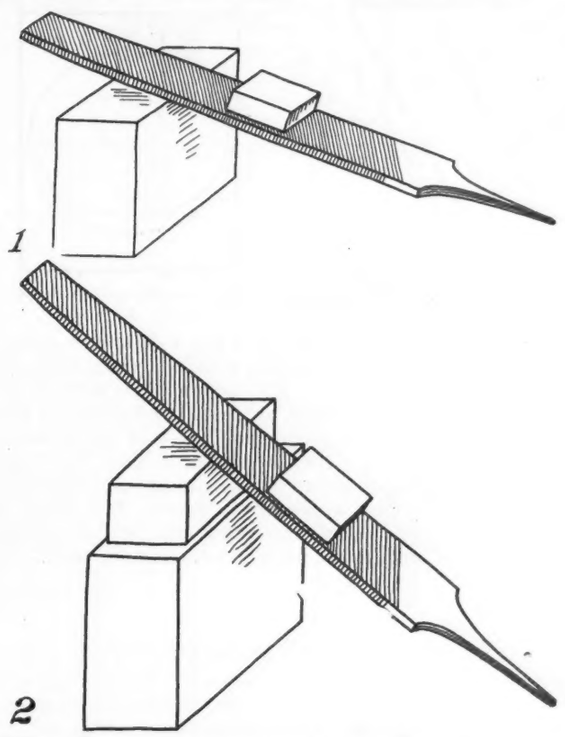
The device should be fastened to the carriage so the connecting rod and crank movement are in line or nearly so, when cutting, so there will be no thrust on the operator. The part planed allows the tool to start and finish each cut in the clear. The throw must be more than the throw of any cam to be turned. JES.

Springfield, Ohio.

THE "BITE" OF A FILE.

"The way to see if a match is good is to strike it"; or, put in another way, "the proof of the pudding is in the eating." Such tests, however, have the disadvantage of using up material—hence, are not always practicable, however practical they may be. So in the matter of file testing, if one has a chance to "shove" the tool under working conditions, it is the best way to test the sharpness. But there is another way which is quite good and, within limits, is helpful to the buyer—although I learned it from a seller.

This looks to the so-called "angle of repose" of a block of metal resting upon the file, while the latter is inclined to the horizontal. Thus, suppose that we have two files, one of which



will keep a flat metal block from sliding, when it is at such a maximum angle as is shown in Fig. 1; while the other, when inclined at such an angle as is shown in Fig. 2, will keep the same block still; then the second one will have the sharper teeth of the two. The maximum angle at which the file lies to the horizontal, while keeping the block in place through the "bite," does not quantitatively measure the sharpness of the file teeth; but it is a pretty good straw by which to judge the wind, and better than the usual thumb tests made over a store counter.

Dresden, Germany. ROBERT GRIMSHAW.

* * *

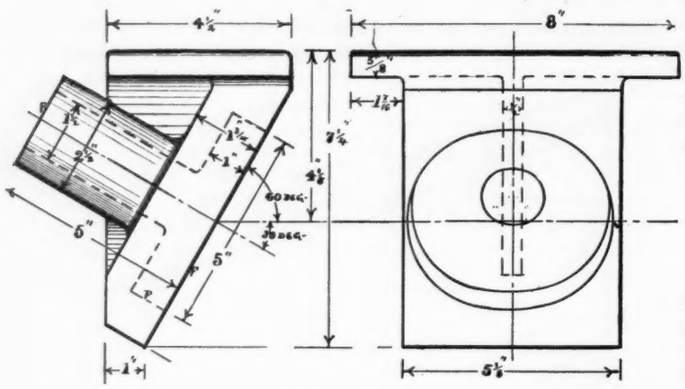
FIGURES RIGHT SIDE UP.

You mention my name in the February issue in connection with the fact that I claim that dimension figures should be placed upright in every case, no matter in which direction the dimension line runs. Enclosed I send you a sketch of a certain piece in a machine which I have recently had built for the —— Mfg. Co.; this I have copied from the original, which was first used by the pattern maker and later by the machinist in machining the same. I am aware that the crude method of placing the figures in all sorts of positions on drawings as per line may run is held to be a standard (!) method by some drawists on paper; but I ask who is authority for placing the letters and figures of the English language (or any other language), for any purpose any other than "right side up" in every case? Surely the figures and letters of language are for the purpose of being read, and read readily, and that method which reads with the most ease and accuracy is certainly the best.

I have seen very many drawings from men supposed to be up in the science of drawing who remind me of some elaborate letter writers, who, after filling the space of their epistles with the usual front to view reading, turn the sheet around one-quarter way and

fill up the margins, and then give the sheet another one-quarter-way hitch and write some more bottom-side up. I have been told that the right method for placing dimension figures for vertical lines is so that the right-hand end or side becomes the bottom of sheet. Indeed! But I have in mind that left-handed man who makes drawings. I am thinking that he would prefer turning his sheet the other way.

Now, Mr. Editor, I have been at this machine-drawing business for many years, and have done some kicking on this line, and I have not got done kicking yet.



Printers and map publishers have got a deal more sense in placing figures on any diagram they make than many mechanical drawists. It is inconvenient to place figures in any position other than right side up from bottom of sheet. It takes time to go to the trouble of turning the sheet around and back and so on; and when that man who is given the drawing to work from begins to look at it, he begins to turn the same round and round to get the right focus on those wrong side up figures. It is wholly unnecessary and inconvenient, and makes one liable to mistakes, which does not occur in the method I have used for years. I am not an inventor of this method; that is the established method of reading the English language. The other fellows are the ones who have "back-slid" from good, common-sense use of figures. If any of these supposed to be up in mechanical drawing fellows who claim so much importance to the figures on vertical lines being turned one-quarter way round want to go to the trouble of sending me a sample drawing of their supposed-to-be correct method, I will copy same and show that what I am advocating is by far the plainest and readily read. FRANCIS W. CLOUGH.

Springfield, Mass.

A LARGE JOB WITH SMALL TOOLS.

Sometime ago we had a job of boring a cylinder of a large slide-valve engine. When the cylinder arrived at the shop it was found that it needed a false face on the valve seat. There was no planer large enough to do the job in, and so rigged up and did it with a 16-inch shaper, which, when stripped for the job, looked as in Fig. 1. We raised the shaper on blocks high enough to clear the top of the steam chest and took the cross rail of a 30-inch planer, and fastened it by making a piece to fit in behind the head, turning it down to fit the end of the ramhead of the shaper, and bolting through to where the stud for the tool-head goes.

The cylinder was then set on V-blocks and bolted against the planed surface on the front of the shaper with bolts arranged as shown in Fig. 2. By fastening a rod from the feed pawl on the cross-feed screw, back to the stud for the up and down feed of the shaper, it fed automatically every time a stroke was taken. The job was done in a fair way, but took a little more scraping than it would if done on a planer. WALTER ALDRIDGE.

Brandon, Manitoba, Can.

* * *

KEEPING ACCOUNT OF DEPARTMENTS.

Mr. Editor: You have probably noticed, if you have had the shop experience that I think you have, how, when anything goes wrong in the shop, it is always the other fellow's department that is to blame. If the other chap had only managed his end half as economically as you had yours, all would have been well and the firm would have declared a 56 per cent. dividend instead of barely making both ends meet.

Now just imagine yourself a general manager of a good-sized shop and have each foreman in the sixteen departments tell you the same thing, and what would you know about the real condition of your plant? Of course, you would look it over and might see dollars going out of some crack, but there might be a hundred creeping out in some other place which you didn't see. Now what is to be done to find the leak, or leaks? First of all, what is the cause of the trouble? Well, personally, I believe it is because too many shops don't know what work costs them to make, for fear of a little extra book-keeping, or a general "guess-it'll-come-out-right" idea. Look at the shops who get into trouble—and some who don't—and see how little real knowledge of the cost of things you find there.

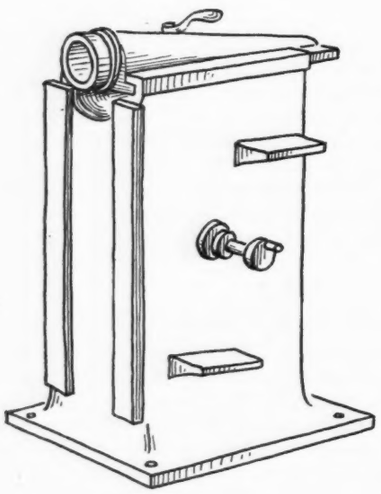


Fig. 1.

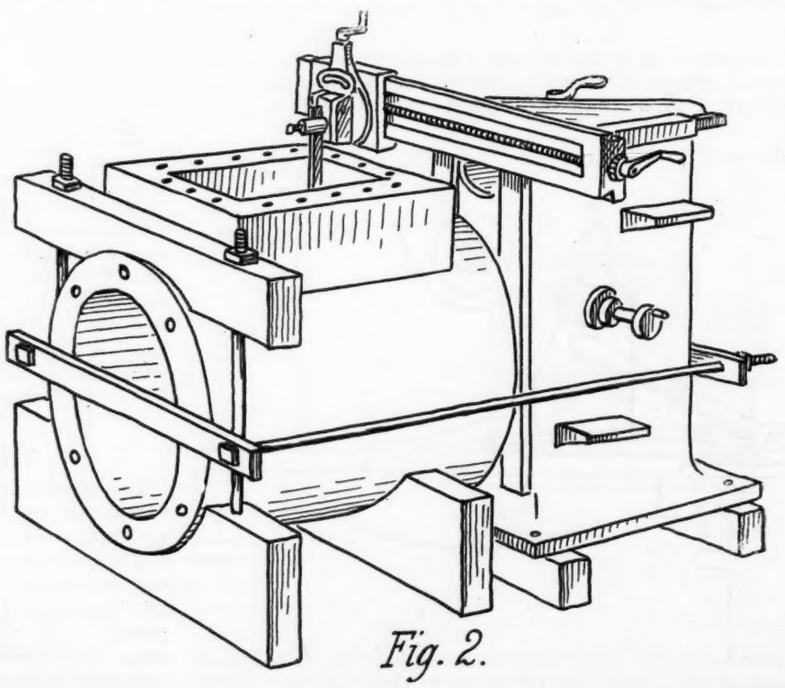


Fig. 2.

I believe that each department of a shop ought to be run as a separate business. The drawing room, office, pattern shop, machine shop, foundry, etc., etc., and even these may be sub-divided with advantage at times when getting at the cost of work and expenses generally.

A poor foreman in one department may "queer" the whole

shop and throw really good work of others into discredit, where the whole thing is lumped together, as in too many places. By keeping cost accounts separate the manager can tell which department is making the most money; which one needs looking after, or which foreman needs improving, and gives him a better idea of his plant than he can get in any other way.

And besides this, it tells in an unmistakable manner which foremen are the best qualified for promotion, and which need to be weeded out; and this is quite an important point in choosing our assistants. I say "our" because I haven't any shop to manage yet, and don't know as I ever shall have, but it has a good sound to say "our" occasionally and try to imagine yourself as something else.

As an example of how these things work in some shops, let me cite an actual case I know of. There is a shop which makes brass goods, valves, oil cups, etc., and whose foundry does a jobbing business besides. In addition, every department does outside work, and yet no account is taken of any department. All the receipts are turned into the common treasury and all bills paid out of it, without any account being taken of what each actually does.

In reality, the foundry earns a big dividend, even though it is poorly equipped, and the brass working shop is also fairly efficient, all things considered, but the tool room and machine department are money eaters with big appetites, and all on account of a foreman who is a botch to begin with and who doesn't care whether school keeps or not. Yet there is no way of proving his incompetency in cold figures, because they lump the whole business.

Well, as I'm not bossing it, I may as well keep quiet, I suppose, but it seems to me that the first principles of business management, whether running a machine shop or selling patent medicine, should be to know the expenses and receipts of each department.

J. B. RICH.

* * *

LIGHT IN THE MACHINE SHOP.

I have often been surprised in visiting various machine shops to find in how many instances very little attention is paid to the question of the most advantageous and economical method of lighting the shop. It seems to me that any proprietor who desires to earn the reputation of turning out good work cannot avoid being somewhat interested in the matter.

I do not mean to infer that a shop, simply because it is well equipped with clean windows, is always going to turn out good work, but I candidly consider that of two shops, the one most likely to be successful, other things being equal, is the one having plenty of light.

It is a well known fact that all of us are more or less affected by the brightness or dullness of the days, and it is equally true in a machine shop, and the more sunlight allowed in them the better it seems to me it will be for all concerned. A well lighted shop conduces largely to the good spirits of the "boys." Moreover, I have seen men with a job in the lathe taking measurements, where the merest trifle would make a palpable difference, dodging around a gas light or candle to get out of the shadow, or to keep from singeing their hair. All this causes divergence of thought and at a time when scarcely anything should bother them except their desire to take accurate measurements. There is also a commercial advantage in a well lighted shop. For instance, suppose a customer comes into such a shop to inquire how work on his order is progressing. He will go away with a better opinion of the shop, and it will perhaps lead him to "come again."

I was working in a shop once which abounded with dark corners, which corners were a constant source of trouble owing to the fact that wrenches, hammers and other small tools would somehow find their way to them, and time was wasted hunting round for them.

I have worked in shops where there were no end of windows, but they were dirty and grimy, and we suffered accordingly with a scarcity of light; whereas, in other shops with less windows, but kept clean, we got along very well.

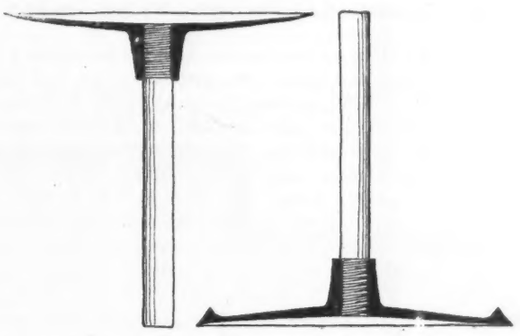
It seems to me that much could be accomplished toward the brightening of many of our shops, especially jobbing shops and those of medium size, by keeping windows clean, preventing obstruction of the light by piles of castings, etc., and a judicious use of the whitewash brush on the inside of the shops.

Port Richmond, S. I. WM. MCFARLAND.

A LESSON IN TEMPERING.

In a small shop in one of the out-of-the-way towns in Maine, they have been having considerable trouble with some special knives they have been making. The knives were simply round discs as shown in the left-hand figure, about 4½ inches in diameter and $\frac{1}{16}$ of an inch or less in thickness, made a little dishing with a *small* hub in the center, where they are screwed on to the end of a shaft and ground to finish. A very thin keen edge for hard wood is necessary for the work they have to do.

The difficulty was in tempering them. They persisted in cracking, and were finally left thick enough so that they would not crack, and were ground to size afterward.



For some reason, however, the temper of cutters made in this way was all right for about perhaps one-quarter of an inch, but inside of that quarter-inch ring they were soft and useless.

The next move was to turn them about as thin as wanted, except the rim, which was left thick, as shown in the right-hand figure, and ground off to produce the cutting edge after hardening; and so far this has proven the most practical method of making them. Perhaps some one can suggest an improvement. The cutters were made from a bar of Jessop's steel, in lots of about one or two dozen, as wanted,

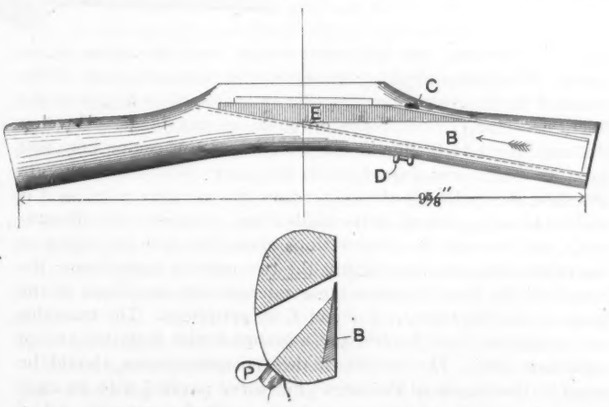
A. HARDCASE.

Portland, Me.

* * *

A HOME-MADE SPOKE SHAVE.

The upper part of the sketch is a bottom view of a home-made spokeshave said to have been made about six years ago, by Mr. H. Gates, of Worcester, Mass., which possesses some novel features. The blade *B* is a straight piece of flat steel beveled on the back edge and fitted nicely to the stock. The front edge is also slightly beveled to give the tightening screw *C* a good hold on it. A small wing nut *D* tightens the screw *C* and holds the blade firmly in place. The shaded portion *E* of the blade shows where



the grinding is done in sharpening it, and as fast as it wears back the blade is pushed in, as indicated by the arrow, until the cutting edge comes forward to the desired position. The opening of the throat is narrowed down whenever desired, in the same manner as widened by drawing the blade out. It will be noticed that the life of the blade depends upon its length instead of its width. In this shave the blade is on the bottom, where it is held in the same relation to the shaving that the blade of a pocket-knife is in whittling, instead of coming down through the body of the shave like a plane iron.

MILO.

PRACTICAL PATTERN MAKING.—10.

PATTERN WORK FOR SCREW PROPELLER CAST ENTIRE.

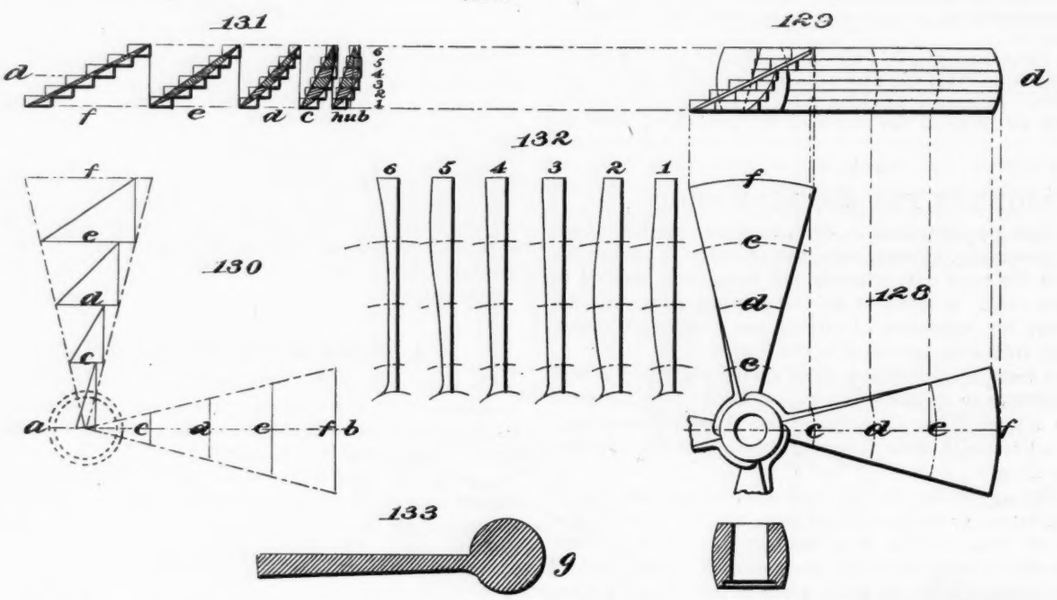
I. McKim Chase.

When screw propellers are of large size and cast entire they are usually swept up in a loam, but when the blades are made separate and are to be bolted to the hub, or when the screw is to be duplicated, a pattern of the blade is usually made and the molding done in dry sand.

To construct the pattern of a screw propeller blade attached to a hub is an interesting and instructive example of pattern making. Working drawings of screws are made in different ways, according to the ideas of the draftsman; one way has been described.

Illustration XVIII shows another method. 128 represents a plan and 129 an elevation of a right screw with two of the four blades broken off. These views are often assumed by the draftsman to be all that is necessary in order to enable the pattern maker to proceed with the construction of the pattern; but the developed sections should be worked out by the draftsman. When they are not so done the pattern maker may develop them himself. In this event, after receiving the drawing, the first thing he should do is to lay down full-size developed sections of the blade. These are readily determined in the following manner: Draw a line *a b*

XVIII



(130), for a center line somewhat longer than the radius of the screw. With the radius of the screw and with one point of the trammel on the center line describe an arc equal in length to the fraction of the circumference occupied by one blade. Develop this arc into a right line at right angles to the center line, and from its extremities draw radii to the center from which the arc was described. Divide the center line into as many parts as it is desired to have sections of the blade (four are used in the illustration), and through the intersections draw lines at right angles to the center line and intersecting the two outside radial lines; the length of the lines between these intersections are those of the bases of the triangles, *c*, *d*, *e* and *f*, or periphery. The triangles are completed (130) by erecting a perpendicular from the end of each base line. The height of these perpendiculars should be equal to the length of the screw, measured parallel with its axis. Now join the top of the perpendicular with the opposite end of the base line by a straight line for a right screw, as that represented.

For the purpose of laying down the thickness of blade at the different sections, as well as the parallel pieces with which the blade is built, it will be found convenient to arrange the triangles as shown at 131.

From a scale of thickness as that shown on the plan view (138) take the thickness of each section, as *c*, *d*, *e*, *f*, and also at the hub. Lay it off at right angles to the center of the hypotenuse of the triangle corresponding in section. From the ends of each hypotenuse describe an arc the radius of which is equal to that of the edge of the blade. For each section describe an arc of a circle intersecting the arcs at the ends and the thickness dimension in the center of the hypotenuse and the area thus inclosed will be the section of the blade at that part.

Now, determine upon the thickness of the parallel pieces, as 1, 2, 3, 4, 5 and 6, to be employed in constructing the pattern. This thickness may vary from 1⅜ to 1¾ inches, according to the size of the blade. Draw lines through the sections of blade parallel with each other and perpendicular to the axis of the screw, with a distance between them equal to the thickness of the material adopted. From each intersection of those parallel lines with the lines bounding the sections of the blade through which they pass, other lines at right angles to them are drawn to the adjacent line, and thus a series of rectangles is produced which represents the widths of the parallel pieces necessary to make the thickness at those parts.

When the screw is a true, or right one, as that under consideration, the face lines of these parallel pieces are right lines radiating from the center of the screw, because a right screw is generated by a right line perpendicular to the axis radiating from the center and having a uniform axial progress while revolving. But all screws are not so made. The generating line is made of various forms and is set at different positions with the axis. It is also given variable as well as uniform axial motion while revolving. Sometimes the generating line is given the form of an arc of a circle described from the rearward of the axial line. In such a case the face line of the parallel pieces will be a spiral of increasing curvature toward the periphery. Then, again, the generatrix may be made a right line radiating from the axis, but having a less axial motion at the axis than at the periphery, producing a screw of diminishing pitch toward the axis. In this latter case when the pattern is built up of pieces of parallel thickness only, the center line between the extremities of the pitches will be a right line perpendicular to and radiating from the axis. With each succeeding piece forward of the center line, the face line will increase in convexity, while for each succeeding piece aft of it the face line will increase in concavity and the face line would have to be worked out for each piece of parallel thickness.

In a case of this kind the construction of the pattern will be made easier by making the pieces tapering instead of parallel in thickness, reducing the thickness of each piece at the axis in proportion to the difference in the pitches; and then the face line of each piece would be a right line radiating from the axis.

The drawing is made convenient for building the screw with the face upward, and some workmen prefer doing it in this way, but the writer, who has had a very large experience in constructing patterns for screws, is decidedly in favor of making them face downward, as greater accuracy can be thereby attained.

All the necessary preliminaries to laying off the different pieces being completed and the material with which the blade is to be

constructed prepared, it is only necessary to transfer the dimensions found to the pieces.

As the method is similar for all of the pieces a description of preparing one will answer for all:

Select for No. 1, or bottom, a piece not less in width than the widest section on that line. Make one edge of it straight and square with the sides, lay off on it the several radi, as *c*, *d*, *e*, *f*, and also the radius of the hub on that line. Beginning either with the hub or the peripheral end, with a pair of dividers step off the width of the section andtransfer it to the arc corresponding radius of the piece. Proceed in a similar manner for each succeed ng section on that line. Take a flexible battern on the piece with its edge pussing through the intersections made on the arcs, darw a line along that edge and work off the piece to that line square with its sides.

Grouped at 132 are shown the different pieces shaped and ready for building the blade.

A surface board is necessary to insure satisfactory work. It should be lined off and the hub secured in its proper position upon it. The piecesare fitted against the hub. As the blade is to be made face upward, a guide secured at the periphery is necessary to secure the proper angle; props are also to be employed beneath the pattern to keep the pieces up to the guide, as there is a tendency of the pieces to depress on their overhanging side. Each piece, as the building up progresses, is set back on the piece below it, and glued and nailed thereto, care being observed that the nails are out of the way of the tools in working the blade off. In the latter case it is only necessary to work down to the lines formed by the outside of the joints to obtain the required thickness throughout the blade. After the blade is worked off it can be made any desired shape within the limits of the pattern by laying off the outline and working off the surplus material, and casing off the back to suit the shape adopted

When the screw is not very large, the hub may be formed at the same time that the blade is being built up by laying off that part of the hub lying in the same plane and the blade portion of the same piece, as shown shaded by *g*. But when the screw is of large size, it is more convenient to turn the hub separately and fit the pieces to it while building the blade.

Unless the screw is quite small, it is not necessary to make more of the pattern than one blade and the hub, as the pattern can be shifted around in molding to make the required number of blades in the casting.

* * *

We have to go away from home to get the news. Here is an important bit of correspondence which is stated, by an English journal, to have occurred between a Wisconsin farmer and a boiler maker: "Dere Sirs, I hav 1,000 akers of trees that I want cut. I'm pore, but I am willing to pay too hundred dolers fer an engin that will do my work," and he went on to explain just what sort of an engine he wanted. The boiler firm saw that the machinery necessary to accomplish the devastation of his virginal forest would cost $3,000, and they wrote to that effect. A week passed, and then the following pithy epistle came back from the Wisconsin woods: "Dere Sirs, what in hqxl wud I want of a biler if I hed $3,000?"

* * *

In 1897 the United States exported to the United Kingdom of Great Britain over 2,375,000 dollars' worth of bicycles and bicycle parts.

THE LE VAN BOILER AND BOILER SETTING.*

In the boiler and boiler setting illustrated herewith the intention has been, so far as possible, to avoid the well-known causes of loss from imperfect combustion, radiation, etc.

The boiler is placed well above the fire-grate so as to provide a deep combustion chamber above the incandescent fuel. Unless this is done the incandescent gases come in contact with the comparatively cool sheets of the boiler and are quenched before they become entirely consumed. Hence the value of a deep combustion chamber.

The air for the supply of the fire is not taken wholly through the ash-pit doors. An air-flue is formed in the outer casing on each side of the boiler, around the back end and under the bridge wall, which receives all the hot air that radiates from the inner walls. By this arrangement the air entering inlet registers

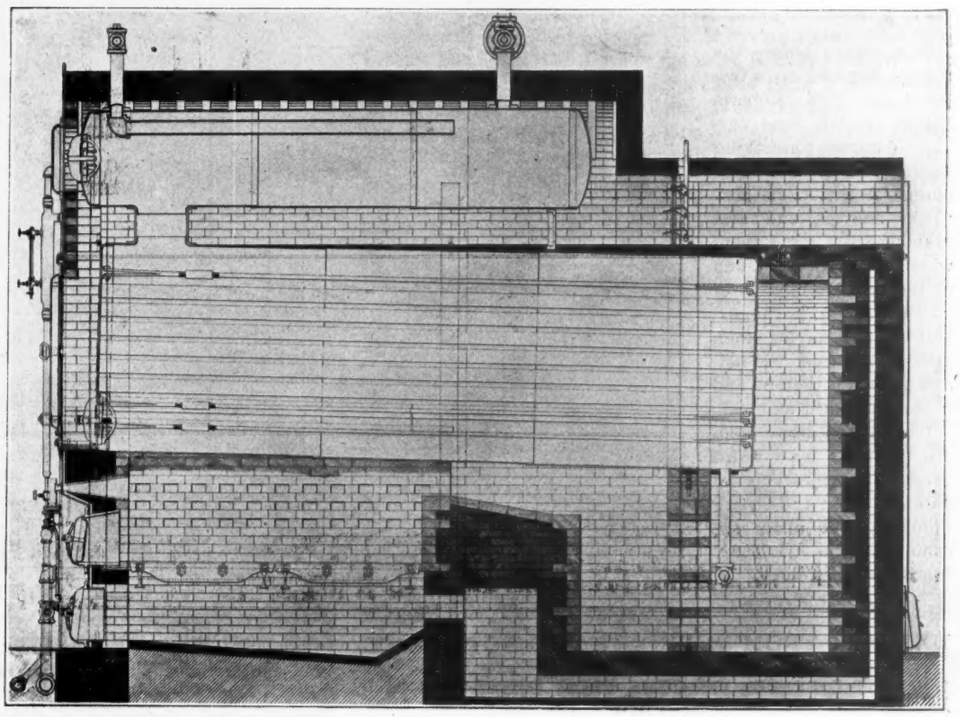


FIG. 1. LE VAN BOILER AND SETTING.

located in the fire-front passes through this heated air passage and is discharged into the ash-pit from the chamber in the bridge wall. In this way it is claimed that the advantages of a hot blast are obtained.

The feed water enters the boiler through the blow-off pipe, which extends from the front to the back end of the boiler, being encased in the setting walls. This pipe is of large diameter, the passage of the feed water through it being slow, affording time for its being heated to nearly the boiling point. Entering the feed water through the blow-off pipe is believed by the designer to be further advantageous in that it keeps this pipe free from sediment and other obstructions.

As will be seen in Fig. 1, the boiler is set at a considerable inclination; this, it is said, with the ample space around and between the tubes (see Fig. 2), provides for a very complete and rapid water circulation, which is always a matter of importance.

Duplex furnaces are used so that they may be fired alternately, thus producing a less disturbing influence than where a single furnace is fired at once and making a change in the air supply unnecessary. It is also found that the division wall between the two fires radiates enough heat during firing, or when cleaning one of the chambers, so that the steam pressure is not materially reduced.

To ensure that the gases and air thoroughly mix and combine a "septum" or division wall is used to separate the fire-grate and combustion chamber from the back end of the boiler where the gases enter the flues. This is believed to retain the gases in prolonged contact with the wetted surface of the shell and to cause them to thoroughly commingle.

The steam dome is large, and isolated from the water and steam

* W. Barnet Le Van, Philadelphia.

space of the shell, being in communication with the latter through a single connection. Any entrained water is re-evaporated in this drum and the steam is slightly superheated.

Mr. Le Van writes that with this boiler and setting, and a chimney 44 feet high, the average temperature of flue gases was only 400 degrees, and with a chimney 125 feet high a result was obtained of 425 degrees temperature and an evaporation of 11.3 pounds per pound of combustible with pea anthracite coal.

Fig. 2 is a cross section, showing at the right the ash-pit and firing openings; at the left, other details are shown.

In Fig. 3 are shown back flue sheet, back flue chamber, etc.

* * *

In a lecture before the British Association, a few years ago, Prof. Roberts Austen quoted some curious old recipes for making liquids to be used in hardening steel, such as: 'Take snayles and first draw water of a red die of which water being taken on the first two months of harvest when it raynes; boil it with snayles; then take your iron red-hot, and quench it therein, and it shall be hard as steel.

I have seen many modern recipes and read several specifications of patents for hardening fluids, all of about the same value as the snail broth of earlier date.

—*Railway Review.*

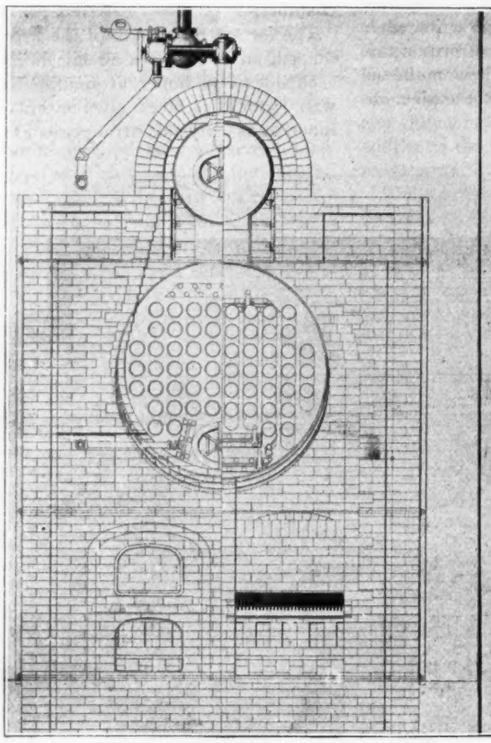


FIG. 2.

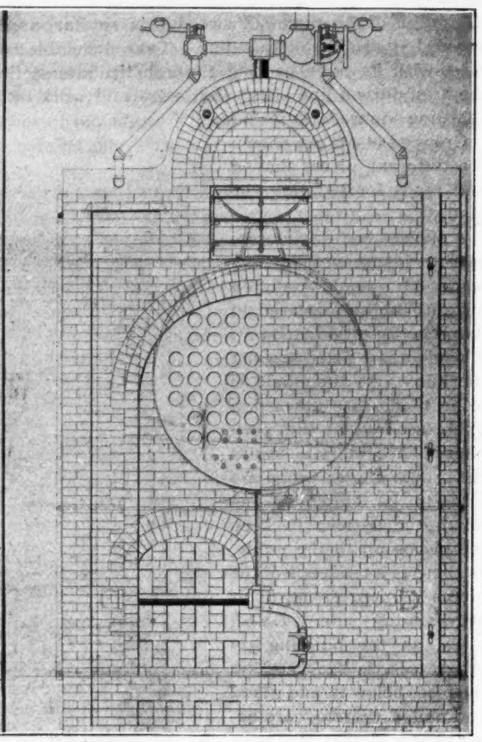


FIG. 3.

EXTRACT FROM WERNER'S OLD NOTE BOOK.

GREAT DIFFERENCES COME FROM OTHER POINTS OF VIEW.

JARNO.

This principle must have been known long before principles were recorded in written words, yet instances of it are ever springing up.

The engineer discovered a pounding that appeared to be between the piston rod and the crosshead. The rod was threaded

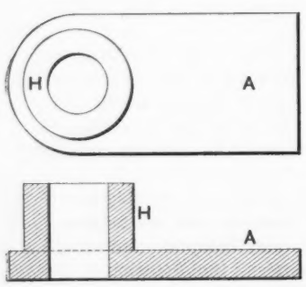


FIG. 2.

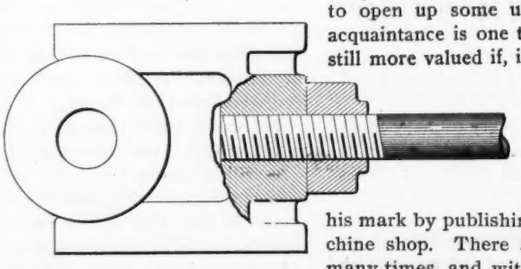


FIG. 1.

through a check nut and into the crosshead, as in Fig. 1. The fit between the rod and the head was supposed to be very snug, and the nut was a further safeguard against end shake and the rod's unscrewing. Now, an end shake at a connecting rod is not uncommon nor particularly troublesome to take out; but an end shake of the piston rod is unusual and is certainly disquieting. Repeated setting-up of the nut had not remedied the pounding, which slowly but surely increased.

The engineer's serious face told but too plainly of his fears, that the situation was becoming very grave. He wanted to stop the engine, but Wanbug would not consent, and so it was kept running. Wanbug journeyed to the engine maker's, and reported to the mechanical superintendent, who at once gave his opinion that the rod was broken in the nut and might be held by only a few threads. He advised Wanbug to telegraph to have the engine stopped. This Wanbug did not do, thinking that the rod would pull through until another could be furnished. The rod did pull through—the cylinder head.

And so, to-day, I am not at work. The rain beats against my window; thoughts and bygone memories come and go, chasing one another much in their own way, while I make but little effort to control them. I have not been to see the wreck in the engine room. Somehow, nowadays, wrecks have lost their fascination, and no longer interest me. I wonder why Wanbug from his point of view did not see what was so clearly apprehended by others. Why has an irony of fate placed the safety of lives and of property with this man who is too obtuse to recognize a danger in machinery and too self-sufficient to act by the opinion of experts?

Gascon has called. I am always glad to see him, for he is sure to open up some unexpected point of view. A very valued acquaintance is one that meets us ever with a new surprise, and still more valued if, in addition, one is uniformly genial and yet just enough reserved to hold us in doubt as to what one's real opinion of us is. Gascon is not inclined to speak of the wreck. He, however, says a few words upon another subject:

"Before long, some writer will make his mark by publishing a book upon the fundamentals in a machine shop. There are some things that have been tried so many times, and with results so uniform, that we must accept the general conclusions as facts.

"The piece, Fig. 2, was held upon a face-plate to turn the hub *H*, and to surface *A* true with the hub. It was essential that the hole be true, which it would most likely have been if the piece could have been turned upon an arbor. It is a fundamental that a hole cannot be kept true while being reamed by any ordinary operation of reaming. The workman was instructed to turn the hole out on the face-plate and not ream it; but, because the hole was not turned smooth, and thinking the instructions of no moment, he did ream it, and the piece was spoiled.

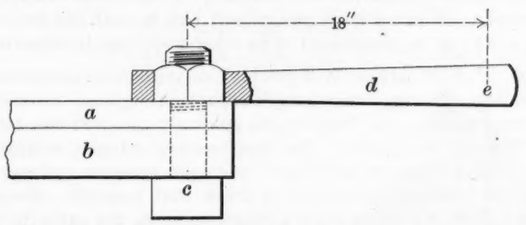
"When two pieces are well fitted, the fit can be easily injured by cramping, when putting the pieces together."

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

62. A. L. R. writes: I am holding some heavy pieces of iron together with four 1¼-inch bolts, threaded 7 threads to the inch. The wrench I use is 18 inches from the center of hole for the nut to where I grasp it with my hand. As near as I can estimate I pull on the wrench with a force of 100 pounds. What I want to ask is: 1. With what pressure are the pieces held together. A. Leaving friction to one side just for the moment, just so many times faster as the hand moves around than the nut moves down, so many times must the 100 pounds exerted by the hand be multiplied to determine the pressure exerted by a single nut to



hold the pieces in contact. Referring to sketch, *a* and *b* are the pieces to be held together, *c* one of the bolts, and *d* the wrench, the center of the hand grasp being at *e*. This point (*e*) will move around a circle 36 inches in diameter. The circumference of a 36-inch circle is 113.0976 inches. The nut has advanced 1-7 inch = .1428 inch, while the hand has been moving through 113.0976 inches. Then 113.0976÷.1428=792; the hand moves 792 times as fast as the nut advances: 792×100=79,200 pounds, the force that would be exerted to hold the pieces together by one bolt, were it not for the friction of the threads and the friction between the surface of the nut and piece *a*. But for this friction the bolt would, perhaps, be parted. It is rather enormous. It cannot be counted upon as being less than about 70 per cent., leaving 30 per cent., or 79,200×.30=23,760 pounds operative to hold the plates together, and for the four bolts, 23,760×4=95,040 pounds. 2. I wish, occasionally, to move these pieces a few feet, bolted together. If I put a strong eye-bolt in the upper piece, hook the crane on and move them, will there be danger of the bolts breaking? The bottom piece weighs about 8,000 pounds and the upper piece about 4,000 pounds. A. Not in the least. The strain on the bolts will not be increased by lifting them as you suggest.

63. L. H. asks: What is the standard taper for gas pipe and taps? A. The recognized taper is ¾ inch to the foot, but from wear of dies pipe as it comes to the user is seldom standard taper. The same taper is employed for taps, we believe. In our opinion, assuming the taps to be standard taper, it would be better, at least for pipes 3 inches in diameter and less, if the taper of the pipe thread was no more than ½ inch to the foot. This would insure a hard fit at the end of the pipe where the pipe crushes more in being screwed into the fitting, and where it is particularly desirable that the thread should make a tight joint, if for no other reason than to prevent the threads rusting together. 2. I have several small ornamental brass articles to clean that are so made that I cannot get into little recesses and corners to clean them. They are very much tarnished. Can you suggest a way to clean them? A. You may succeed by using a solution of 4 ounces sulphuric acid, 3 ounces nitric acid, 2 drachms saltpeter and 4 ounces salt water. Let this stand for three or four hours. If you can remove the ornaments dip them in this solution and wash with soft water and dry in sawdust. If you cannot remove them apply the solution with a swab or brush, and wash and dry at once.

64. F. F. F. writes: We have been having a good deal of steam pipe put through our factory, from ½ inch to 2 inches diameter. There are about 50 globe valves in this pipe and they are so put in that the steam comes to the top of the valve and passes down. It was my idea having them placed in this way, my argument being that if the threads strips the valve will be closed, and perhaps prevent injury to something else. I also claim that the steam being above the valve keeps it seated more firmly, and it will not be so likely to leak. My engineer claims that the usual practice is to put them in so that the pressure from the boiler comes against the under side of the valve, and he thinks that the best way. Which is right? A. We think your engineer is right. It was once very common to put in valves as you suggest, and some users now insist upon their being so placed, their argument being the same as yours, but we should think it safe to say that three out of every four are put in so that the pressure is under the valve. As globe valves are made the thread seldom slips; so seldom as to scarcely be worth considering. As to the valve seating tight, there is no difficulty in doing this in the instance of any valve worth having. An advantage of having steam come from beneath the valve is that when the valve is closed the stem can be packed; also, when the valve is closed there is no pressure on the packing to eat and burn it out. When the valve closes with the pressure instead of against, it is liable to clatter in closing and when nearly closed, wearing both valve and seat and causing a leak. When it closes against the pressure it will close evenly and smoothly.

65. L. B. writes: 1. I want to drive one shaft from another, but I want to vary the speed of the driven shaft, at times, just the merest trifle; much less than it is practicable to do with ordinary step cones. My friend tells me that he thinks I could use cone pulleys without steps. Do you think they would be satisfactory? The driving is light, and only a small range of speed is required. The shafts will be 24 feet apart. A. We presume your friend refers to some such arrangement as that shown in Fig. 1. Such cone pulleys were considerably used some years since, but they have gradually gone out of use. The driving was never satisfactory, we believe, although we have seen iron planers of considerable size driven fairly well by them. One large firm, if we are not mistaken, supplied them exclusively for driving iron planers of their manufacture, and, we presume, for other purposes. One reason for their unsatisfactory driving may be seen from an inspection of Fig. 2, in which the taper of the cone is exaggerated. The belt would naturally lead as indicated by the

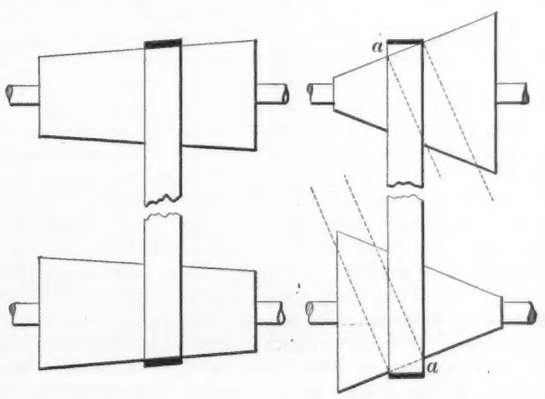


FIG 1. FIG 2.

broken lines, but is restrained by the cone of the second pulley. The cones play at cross purposes, and it is evident that there will be a side twist in the belt near each pulley and a good deal of side slip on the pulleys. If the belt did lie evenly, as indicated in the sketch, it is evident only one edge of it would be in contact with the pulley, as indicated. While the belt would yield so that its entire width would touch the pulley it would be a mere touch at *a a*. The belt would have but little capacity for driving for more than half its width. The very considerable distance apart of the shafts is in favor of driving as you suggest, and as you say the driving will be light you probably may make the plain cones serve your purpose. Use a pliable belt; perhaps a cotton belt may be best; possibly you may have to use a shipper at each cone, arranged with rollers to protect the edges of the belt, to prevent the belt from climbing up the cones. This you can determine by trial. 2. What should be

the taper of the cones? A. For your purpose we should make the taper no more than 2 inches to the foot, although we have seen 3-inch, possibly 4-inch tapers.

66. J. R. G. writes: I wish to know if a valve motion that will operate a slide valve so as to cut off automatically from zero to full stroke, and act as a reversing gear if desired, will be as efficient as the Corliss system; and if not, why not. *A*. With a slide valve you must necessarily have large clearance spaces, and both the hot inlet and the cooler exhaust steam will have to pass through the same passages and valve, features that are against economy. With a slide valve, moreover, you cannot cut off much before half stroke without causing excessive compression. This is sometimes overcome by increasing the clearance space, which, however, is against economy. Cutting off at half stroke or later brings the terminal pressure high—another bad feature, which may be offset somewhat, however, by using a throttling governor instead of running automatically, as you propose to do. With your gear you will not secure Corliss economy. See editorial upon the "Economy of the Corliss Engine," in this issue. 2. Would it be expedient to patent the gear? *A*. No.

67. F. C. S. writes: We have taken apart a Bement & Miles vertical boring mill in our shop, and the step bearing is shaped something like the enclosed sketch (Fig. 1). A says that the bearing is made in this way because such a construction does away with friction: B says that there can be no such thing as a bearing without friction, but does not know what the advantage is. Information wanted. *A*. The bearing used by Bement & Miles is known as a "Schiele" bearing, named from the man who first used it. It has often been called an "anti-friction" bearing,

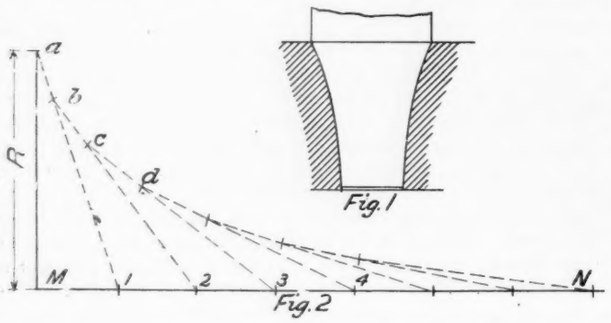


Fig. 2

Fig. 1

which, however, it is not, for there can be no such thing, just as B says. The advantage of this shape is that the pressure is uniform all over the rubbing surfaces, thus giving a very even bearing. Another quality is that the vertical wear is the same at every point, and as the spindle wears and drops down it retains its shape and hence its uniform bearing. The only objection to this design is the cost of construction, so that where there is thrust to be taken it is generally preferred to support the shaft in a plain cylindrical bearing and take care of the thrust in some other way, especially since the introduction of roller and ball bearings 2. Please tell according to what principle this bearing is made. *A*. It is said that Mr. Schiele discovered this form by noticing the shape taken on by pivot bearings in the natural process of wear. The following approximate method of laying out the curve is given by John Richards in his Manual of Machine Design. In Fig. 2 is a diagram in which M N is a central axis of a spindle, which for convenience is supposed to be in a horizontal instead of a vertical position, as in Fig. 1. Having drawn M N, decide upon the radius R, of the spindle. Lay off upon M N a number of equal spaces, 1, 2, 3, 4, etc. Draw a line from point 1 to point *a*. Set the compasses to the diameter R and with point 2 as a center, strike an arc cutting the line 1 *a* at *b*. From this point draw a line to 2 and then with the compasses still set to dimension R, and with 3 as a center, strike an arc cutting the last line drawn at *c*. From *c* draw the line *c* 3, and with 4 as a center strike another arc, and so on. Through points *a*, *b*, *c*, etc., draw the curve. A peculiar property of this curve is that all tangents to the curve drawn to the line M N will be of the same length.

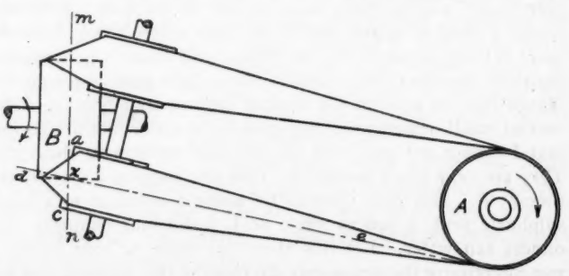
68. L. D. writes: I wish to use two kinds of cement, one of which shall be fireproof and the other waterproof. How can I prepare cement for these purposes in small quantities? A. For a fireproof cement mix asbestos with silicate of soda. Aquarium cement is the best waterproof cement we know of. To prepare it mix together one pound of litharge, one pound of clean, white sand, one pound plaster of paris and six ounces of rosin. Use sufficient boiled linseed oil to make it of the right consistency.

69. L. B. R. asks: What is a soft patch on a boiler and how is it made? *A*. Boiler-makers are accustomed to speak of any patch on a boiler that is put on with bolts or screws instead of rivets, as a soft patch. 2. What is a hard patch? *A*. Any patch put on by riveting and caulking in the usual way. 3. What is clinker composed of, and is its presence evidence of improper firing? *A*. What an engineer understands by clinker is made up of incombustible matter in the coal, and is not necessarily evidence of poor firing. When the firing may be quite easy these impurities may pass off as ash or small pieces of stone. When it must be fairly hard the impurities are vitrified, forming clinker. 4. In firing stationary boilers, which should be carried the heaviest, a hard coal or a soft coal fire? *A*. Generally speaking a soft coal fire is carried the heaviest. There is no rule for this, however. Whether hard coal or soft coal is used, the best depth for a fire can be determined in no other way than by experiment.

70. P. E, R. writes: Will you give me the correct proportions of cylinders, also receivers for triple expansion engines? I should like a rough sketch. *A*. There is no generally accepted rule for proportioning these parts. The intermediate cylinder is generally from 2 to 3 times the capacity of the high pressure cylinder, and the low pressure from 5 to 10 times that capacity. Receivers have all the way from 1½ to 4 times, or more, the capacity of the cylinder from which they receive steam. We could not give you a rough sketch that would be of any advantage to you. The proportions and arrangement of parts is something that must be worked out from a careful consideration of all existing conditions and from an extended observation of the practice of others.

71. J. D. writes: I have a boiler used for a small machine shop. Water power is sufficient for about nine months in the year, during which time the boiler is laid up. What is a good way to protect it against rust during this time? *A*. There are two ways in which you may do this. In either way the boiler must be quite tight. One way is to put from one to two gallons of crude petroleum in the boiler, then fill it quite full of water. Allow the water to run out quite slowly; being sure that it is all out, build a slight fire of shavings to dry it, and close it tight. Another way is to dissolve four or five pounds of sal soda, empty it into the boiler and fill entirely full of water, close tight and let it stand in this way. Whichever way you adopt it will not rust if it is sealed against the atmosphere.

72. E. C. P. sends a sketch of a belting arrangement for driving two shafts at right angles, one of which is above the other; and wants to know how to find the angle at which the guide-pulley shaft should be set. *A*. This case is quite simple, because the two pulleys, A and B, are of the same diameter, and the upper and lower parts of the belt are parallel all the way, while the two guide-pulleys can run loose on the same shaft. In laying out belting the one and only rule necessary is to make the belt as it passes from each pulley lead into the plane of the next pulley. By "plane of a pulley" is meant a central plane through the pulley



at right angles to the shaft, as though we cut down through the pulley B on the line *m n*. Supposing A to be the driver and to turn in the direction indicated, the belt, as it passes off from the lower guide-pulley, must enter the plane *m n* of pulley B. The center of edge *a c* of the guide-pulley must therefore lie at some point on the line *m n*, preferably at *x* as drawn; for if it were above or below *x*, the belt would run off if ever moved backwards. This condition fixes the position of *a c*, and now we must obtain its angle. This is done by noticing that as the belt leaves A it must deliver into the plane of the guide-pulley. Hence *a c* must be at right angles to the center line *d e*. Having found the posi-

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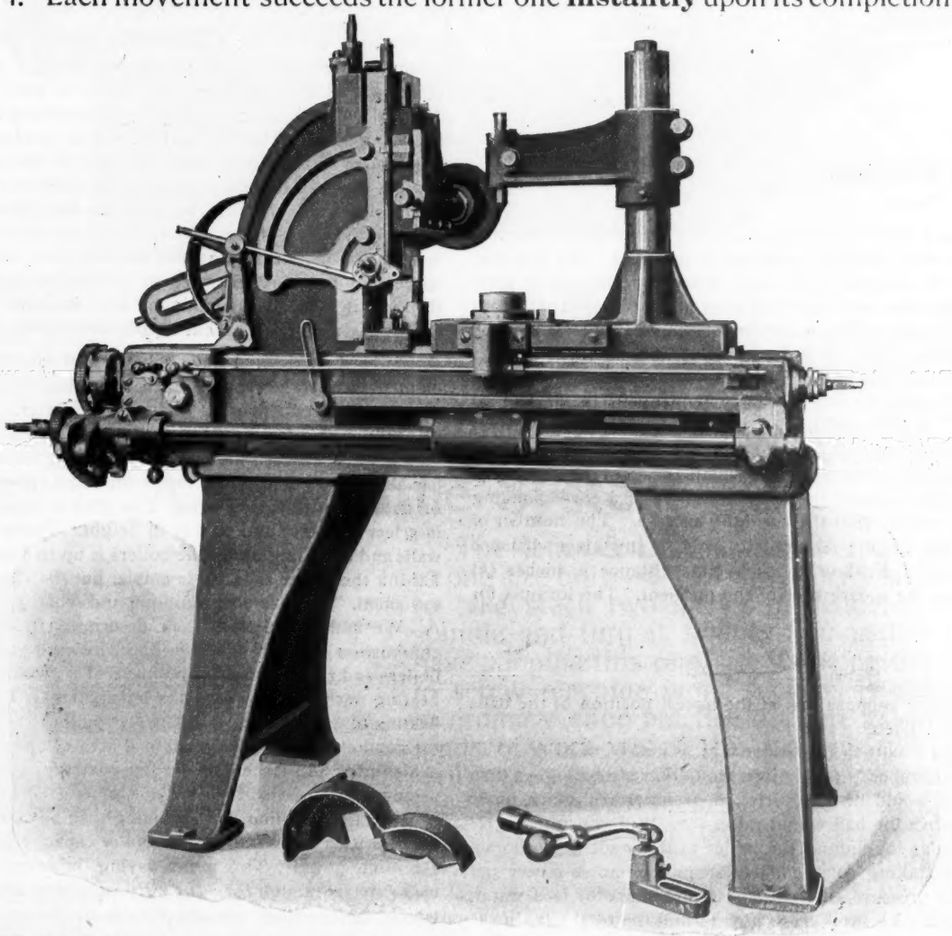

SAFETY—

1. Each movement depends upon the completion of the previous movement. The cutter cannot by any possibility advance into the blank until the spacing is completed.
2. Each movement is driven positively. No accident can happen through the failure of friction devices.
3. In starting, the first movement is a spacing movement, thus taking up the lost motion first.

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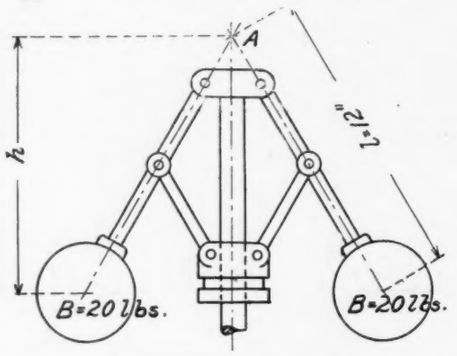
tion of the lower guide-pulley, this determines the shaft position as well as that of the upper pulley. In case A and B should be of different diameters the upper and lower guide-pulleys would be at different angles.

73. J. M. G. writes: Suppose I have a governor which has 20-pound balls and the arms are 12 inches long. Kindly give me the formula for finding the speed that the governor must run to raise the balls. A. In dealing with governors the position of the balls is generally designated by stating the perpendicular distance from the point *A*, where the upper end of the arms intersect the center line of the spindle, to a horizontal line passing through centers of the balls, or the distance *h* in the figure. The length of the arms must be taken as *l*, the distance from the center of the balls



to point *A*, and it is evident that with the sketch as drawn, this length varies with different positions of the balls. We will also assume that the weights of the balls *B* are concentrated at their centers and that the weights of the arms may be neglected. Both of these assumptions are wrong, and in some instances may be very far from the truth, but if the actual conditions of the weights and arms be taken, the problem becomes quite complicated. Little is gained by trying to use too many refinements in mechanical calculations. It is a peculiar property of pendulum governors that the distance *h* is independent of the weight of the balls and depends solely upon the speed at which the governor revolves. That is, at a given speed the balls will stand at a corresponding distance, no matter what their weight may be. The number of revolutions per minute required to make *h* any given distance may be found by dividing 35,294 by this distance in inches (*h*) and extracting the square root of the quotient. The formula for this is

$$N = \sqrt{\frac{35294}{h}}$$

For convenience, suppose that at the lowest position of the balls $h = 12$ inches. Then,

$$35294 \div 12 = 2{,}941; \quad \sqrt{2941} = 54.25 \text{ nearly, } = N.$$

In reality the number of revolutions would have to be higher than this, as there would be some friction or other resistance to be overcome before the ball would raise. 2. Will you please give me the formulas for finding the boiler capacity for a 300 horse-power engine taking 20 pounds of steam per horse-power per hour. Gauge pressure, 105 pounds; temperature of feed water, 190 degrees. Please show, first, how to find the total heat in the steam, then in the feed water and finally the whole thing. A. The only convenient and, in fact, the only practical way of working steam examples is to have a table of the properties of saturated steam at hand. From such a table we find the total heat in one pound of steam at 105 pounds gauge pressure (120 absolute pressure) to be 1,186 B. T. U. (Britsh thermal units). The B. T. U. in water can be found approximately by subtracting 32, the temperature at the freezing point, from the temperature of the water. In this case the thermal units in one pound of the feed water = 190 — 32 = 158. To convert this water into steam at 105 pounds pressure, therefore, will require an expenditure of 1,186 — 158 = 1,028 B. T. U. The steam required to run the engine one hour is 300 × 20 = 6,000 pounds, and the thermal units necessary to produce it are 6,000 × 1,028 = 6,168,000. Boiler capacity is usually stated, either by giving the evaporation from and at 212 degrees, or else by giving the horse-power according to the rating adopted by the American Society of Mechanical Engineers. 1st, to evaporate one pound of steam from and at 212 degrees requires an expenditure of 965.7 B. T. U. Hence, to reduce our evaporation of 6,000 pounds, requiring 6,168,000 B. T. U. to this standard we have 6,168,000 ÷ 965.7 = 6,387 pounds that would be necessary from and at 212 degrees. 2d. The horse-power rating makes a boiler evaporating 30 pounds of water of 100 degrees temperature into steam at 70 pounds gauge pressure develop one horse-power. This is equivalent to 34½ pounds evaporated from and at 212 degrees. Hence, our boiler should be one of at least 6,387 ÷ 34.5 = 185 horse-power.

74. M. E. B. writes: I find trouble in getting a good surface casehardening on pieces of machinery steel. I use prussiate of potash for wrought iron, very successfully, but find trouble in getting the steel hard on the surface. Can you tell me the probable trouble? A. Machinery steel may be casehardened by using prussiate of potash, the same as for wrought iron, but a little more patience is required. Heat the pieces in a coke (not fresh coal) fire, and cover the surface very completely with the potash, then reheat and cover again with the potash, repeating the operation three, or even four times. Finally, heat and quench in clean, cold water. We think you will have no trouble in getting a hard surface in this way.

75. J. D. E. writes: I propose to build a refrigerator by enclosing the cool box with a space in which a vacuum is maintained. Will there not be a very material gain in this? A. We doubt if you will gain anything by maintaining a vacuum in the enclosing space. The outside heat will be conducted through the outer plate and will pass from the outer to the inner plate by radiation, which, if there is nothing (a vacuum) between these plates, will, we should presume, be quite as free through vacuum as through the atmosphere. While we do not state this as a fact, we believe that maintaining a pressure of several atmospheres in the space will be more effective in preventing heat from passing through it than the maintaining of a vacuum. We should not expect any noticeable benefit or loss from doing either.

76. H. L. writes: I have a battery of four boilers, 48 inches diameter and 20 feet long. Each boiler has five flues 8 inches in diameter and two flues 12 inches in diameter. There are three furnaces, each 4 feet by a little more than 5 feet. There are no dividing walls between the boilers, but the furnaces are divided. I use about 150 horse-power in the mill, and cannot keep up steam on days when the air is light. The draft is first-class. The stack is 5 feet diameter and 90 feet in height. There are good bridge walls and the filling under the boilers is up to 8 inches of the shell. I think the boiler capacity is ample, but that the grate surface is too small. What is your opinion, and what would you suggest? A. We understand from your description that the products of combustion pass, from the furnace, forward and underneath the boilers and return through the flues. This would give you a total heating surface of about 1,773 square feet. The proportion of heating to grate surface is 1 to 22. It ought to be 1 to 30 or 1 to 35 for good economy. The combined area of opening through flues is also none too large, but, on the contrary, a little small for the present grate surface. We do not know what kind of engine you use, nor its condition, but assuming it to be about the average of engines used in such mills, the boiler capacity is a little small for 150 horse-power. This is not saying, however, that you cannot make steam enough for your purpose if you are not particular—which, we presume, you are not—as to the amount of fuel consumed. Enlarging the grate surface 25 per cent. may give it to you, probably will, but it is not so sure to do so as running with closed ash-pit doors and using a fan blower to deliver air under the grates.

77. C. M. W. Writes: I wish to use a considerable number of taper screw plugs, the taper of which is to be sharp. I should like to make the taper not less than ½ inch to the inch, preferably more. Can I make plugs of this taper that will be satisfactory to hold pressure, or will the sharp taper prevent their being screwed up tight enough, and in cutting the thread on tap and plugs should the tool be set true (that is, at right angles to) the taper? A. A taper screw thread is at the best unmechanical, and the greater the taper the more unmechanical it becomes. We should never make plugs for the purpose you mention of greater taper than ½ inch to the foot. In cutting the thread set your tool at right angles to the axis of the tap if you have taper attachment to lathe. If you have to set the tail spindle over to get the taper, then set the tool precisely as you would if you were to cut a thread on a straight piece.

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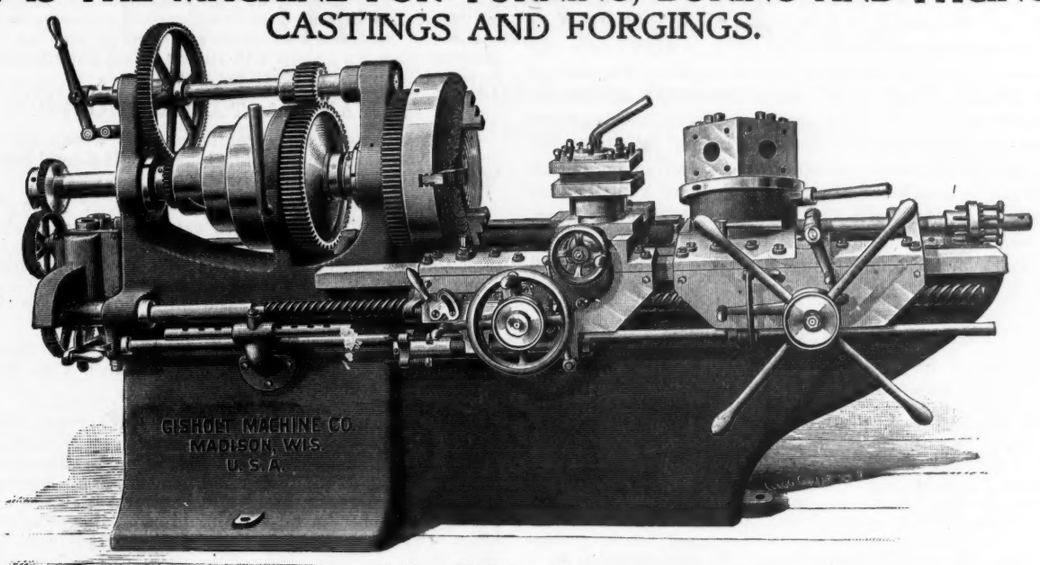

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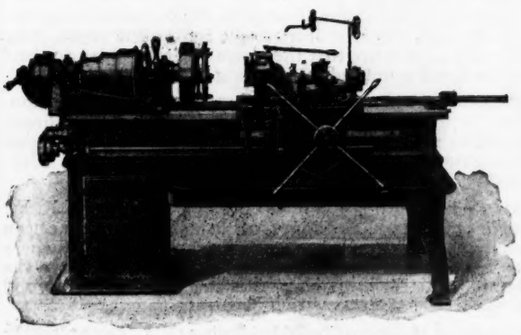

The Jones & Lamson Flat Turret Lathe is made in one size only---2 x 24, meaning that it is intended to take stock two inches in diameter through the spindle and turn it twenty-four inches long. We have adopted this one size as being the best suited to screw machine work such as is generally made in ordinary shop practice. There are three distinct kinds of work which this machine will do. (1). It will make screws, studs, bolts and all small parts from the bar up to two inches in diameter. (2). It will do all wrought iron and steel work above two inches in diameter, which properly comes within the range of a turret machine. For work of this size we recommend that the pieces be finished from forgings, as it can be done to better advantage on our regular size machine in this way than when made from a bar of large size and a machine large enough to take the bar. Heavy bars through the spindle tend to tear things to pieces and do not permit of quick and easy operation. The amount of stock to be removed where bars of large size are used without forging becomes also a serious obstacle in the way of cheap production, for as the work increases in diameter, the stock that is removed increases nearly as the square of the diameter. (3). By using the special jig tools which can be fitted to our regular machine, cast iron and steel work that is held in the chuck can be finished economically up to the full swing of the lathe. These jig tools consist of iron plates, which are bolted to the flat turret and to which are fastened all the tools for the various operations. When a job is completed these plates are removed from the machine and put on the shelf in the tool room, the tools remaining set ready for the next time the same piece of work is to be done. The time for setting up work of this character, therefore, is much less than on the ordinary type of turret chucking machines.

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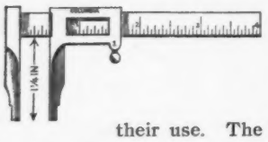
A POCKET CALIPER.



The various forms of the "Columbia" calipers made by E. G. Smith, Columbia, Pa., are well known among mechanics as convenient tools for their use. The latest form that Mr. Smith has brought out is that shown in the illustration, which is intended for pocket use. It consists of a sliding or beam caliper with an eccentric for fastening the sliding jaw to the scale when set for any size. This device is very convenient for the smaller sized calipers which are usually carried in the pocket, since it takes up less room than the one with the screw tightening device, besides, there is no danger of losing any part from this caliper, as is often the case with the old-style ones. Another point of advantage is that the caliper can be handled and used with one hand, and when set to the work to be measured, can be tightened with one hand, while holding the work in the other. It is made in the 4- and 6-inch size in all standard graduations. A catalog will be sent to all interested.

* * *

FRESH FROM THE PRESS.

THE MECHANICAL ENGINEER is the name of a new English engineering weekly published by The Scientific Publishing Co., Hodson's Court, Corporation street, Manchester. It is edited by William H. Fowler, a well-known mechanical engineer, and the paper is one of the handsomest publications that comes to this office. It is devoted strictly to mechanical engineering subjects and contains 35 reading pages in each issue. We judge from present appearances that the journal is to be conducted on a high plane, and that an effort is being made to secure matter of real merit from the standpoint of the engineer and machine constructor. The price in this country is 25s. per year, or about $6.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9 x 12, 6 x 9 AND 3½ x 6 INCHES. THE 6 x 9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

MONTGOMERY & CO., 105 Fulton street. New York. Illustrated catalog and price-list of supplies, tools and machinery for all branches of the mechanical trades.

This 1898 edition of the tool catalog contains over five hundred pages of pocket size. It is printed on thin paper, has rounded corners, and the matter is condensed into the smallest space possible, consistent with clearness. It forms, therefore, a convenient, compact book of reference for those in the different branches of mechanical work, and would be a valuable desk book. It does not list all the tools and supplies handled by Montgomery & Co., but includes only those for which there is the most call. At the same time the number of articles listed is very large, and we believe the catalog is one that mechanics generally will appreciate. A discount sheet is sent with each copy, and the price is 25 cents.

THE MERIDEN MACHINE TOOL CO., Meriden, Conn. Illustrated catalog and price-list of Forming Lathes. 46 pages, standard (6 x 9) size.

The interesting feature of this catalog is that it is devoted exclusively to forming lathes and tools. The 46 pages of matter show the possibilities in the development of one small branch of the machine tool business by specializing. The valuable feature of the catalog is that it tells everything that a prospective buyer would want to know about forming tools, including many valuable suggestions for this class of work, and detailed information upon estimating. A regular line of lathes is listed, besides various fixtures or attachments that this company or their customers have found valuable for broadening their scope of work in certain instances. A combined forming lathe and screw machine is also made, which is complete and satisfactory for either purpose.

BACKUS WATER MOTOR CO., Newark, N. J. Catalog of the Backus Gas Engine. 24 pages, 6 x 9½, illustrated.

This catalog shows both horizontal and vertical styles of engines which, it is stated, are made in sizes ranging from ¼ to 100 horse-power. The large sizes are provided with self-starters.

WE have received from L. Coes & Co. an artistic circular of machine knives, and of their improved composite stock of welded steel and wrought iron, to be used where there is wanted a soft backing and a hard wearing face.

FAY & SCOTT, Dexter, Me. Special Catalog of Pattern Makers' Lathes. 20 pages, 6 x 9 inches, illustrated.

A complete line of pattern makers' lathes is illustrated, ranging in size from a 10-inch lathe for manual training schools to a 66-inch gap lathe and an 84-inch face-plate lathe. Full specifications are given for each lathe, and the catalog is free.

THE INGERSOLL-SERGEANT DRILL CO., New York, have issued a booklet which is a condensed edition of their catalog of air compressors. It contains illustrations of the various types and shows some of their uses. It is sent upon application.

PATTERSON, GOTTFRIED & HUNTER, LTD., 146-150 Center Street, New York, have issued a small catalog of rubber goods, including belting, hose, packing, matting, etc.

THE CHARLES B. KING CO., Detroit, Mich., have sent us a second edition of their catalog of Gasoline Engines for marine purposes. One of their engines was illustrated in our last issue.

WE have received from the Crafts Machine and Tool Co., Buffalo, N. Y., a circular of the Crafts' latest improved speed-changing device, as arranged in the form of self-contained countershafts and as applied to planers. There is also an illustration showing plans for a shop with all belt drives underneath the floor, leaving free overhead space for cranes.

MANUFACTURERS' NOTES.

IN the last issue we gave the address wrong for the newly formed American Laundry Machine Co. It should have been 127 West Thirty-second street, New York.

THE HOPPES MANUFACTURING COMPANY, of Springfield Ohio, manufacturers of live steam feed water purifiers and exhaust steam feed water heaters, report large orders recently received through their Philadelphia office, from the New York Sugar Refining Co., Long Island City, N. Y., and the Union Traction Co., Philadelphia, aggregating nearly 12,000 horse-power. The Springfield office of this company also reports large sales.

DIETZ, SCHUMACHER & BOYE inform us that they are now located in their new factory, corner Queen City Avenue and Buck Street, Cincinnati, O.

THE fifth edition of WRIGHT'S TRADE DIRECTORY AND GAZETEER is now being compiled by the publisher, Geo. Wright, 121 Fulton street, New York. This book, which comprises about 3,000 pages, 6 x 9, includes all the trades and professions in Australia, India, China, Japan, Canada, South and Central America, Mexico, West Indies and South Africa, and should be a valuable addition to the office of any manufacturer who is seeking trade with those countries.

THE NICHOLSON FILE CO., of Providence, R. I., acting through the Great Western File Co., of Beaver Falls, Pa., its Western branch, has just leased for a term of years the plant and good-will of the McClellan File Co., of Saginaw, Mich., makers of the McClellan brand of files and rasps. The Nicholson Co. will continue the manufacture of the McClellan brand in connection with its Great Western brand, the product of its Great Western branch. With this addition to their plant the Nicholson File Co. now control and operate five distinct factories, with a joint capacity of 64,000 dozen, of 76,800 files daily, representing, it is claimed, about 70 per cent. of the entire production of files and rasps in the United States.

JAMES L. ROBERTSON & SONS, dealers in steam supplies, call attention to a change in address from 204 to 196 Fulton street, New York. They also announce that they have recently added to their equipment for turning out indicator piping of superior quality.

THE CENTRAL MACHINERY AND TOOL WAREHOUSE of C. W. Burton, Griffiths & Co., of London, the representatives of several firms, have removed to new and enlarged quarters at 1, 2 and 3 Ludgate Square, Ludgate Hill, London. They were formerly at 4 Playhouse Yard.

FREDERICK WIARD AND J. W. PRATT, 39 State St., Batavia, N. Y., have brought out a new shaft hanger and belt shifter in connection with a countershaft, which is particularly adapted to work where machinery is idle a part of the time, and is intended to save the wear of boxes and stretch of belts. It is said to have given good results in use.

THE FERRACUTE MACHINE CO., of Bridgeton, N. J., have recently sent a large outfit of fine machinery, with automatic feeding attachments, to a foreign government for making coin. They have also supplied a number of these coining presses for compression work, that is, forming short pieces of rod into articles which were formerly forged or turned from the bar. This method is used for studs, horse-shoe calks and various other small articles of the same nature.

MILLING MACHINE DESIGN.—Complete working drawings—single detail, per sheet plan—of a universal hand-feed miller, are nearing completion. This design is a type of the class to which it belongs, and in it are embodied many desirable features, which cannot be obtained, following the usual lines. The drawings are for two sizes—one for bench use, the other resting upon its own base—and five attachments, and are offered at an attractive price, quality considered. Correspondence from live manufacturers solicited. OTTO E. EVANS, York, Neb.

SMALL ENGINES AND BOILERS.—Engine castings, $2.00 up. Water motors, gas engines, locomotives and castings. Circulars. GRANT R. SIPP, Paterson, N. J.

WANTED.—A mechanic with a little money to help market a new tool, for which there is a good sale in almost every machine shop. Investigate this, please. Address "Merit," care of MACHINERY.

If it's the wrong make, try the ARCADE.

Try them at our risk, not at yours; and if they don't cut as fast and wear as well as hand cut, send them back at our expense.

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"This blow about machine-cut files being as good as hand-cut makes me tired. I've got one here and it's no good."

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EDITOR'S NOTES.

Probably some young mechanics who see the words "Transmission Dynamometers" over the article in this issue written by Mr. Webber, will skip the article because they think it will be of no benefit to them and too difficult for them to understand. If any have done this we advise them to turn back and read the article. The first line explains the meaning of the word "dynamometer"—an instrument for measuring power—and Transmission Dynamometers, of course, are instruments for measuring power transmitted from one machine or line of shafting to another by placing the instrument so that the power will have to be transmitted through it where the power can be measured. Mr. Webber is a well-known authority upon the subject of dynamometers, and has written this article in such simple terms that any young mechanic will be able to comprehend it. This is one of a number of articles which we hope to have from different authors bearing upon the subject of power transmission.

If any questions come up in the shop to bother you that you think if answered could be of interest to other mechanics besides yourself, send them to us and we will puzzle our brains over them and answer them if we can. A great deal of practical information can be gathered together in this way and given to the readers of "Machinery" which will be of great value and help to those who are engaged in machine construction. Already we believe this department of the paper is proving of real help to many of our readers.

In this number Mr. Snow presents strong arguments in favor of mechanical draft, as opposed to chimney, or natural draft. It is a subject that must at least have careful attention from those who are interested in steam economy.

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